Draft Supplemental Environmental Impact Statement for the Prototype Oil Shale Leasing Program

IN REPLY REFER TO

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
COLORADO STATE OFFICE
1037 20th STREET
DENVER, CO 80202

NOTICE

This is the Draft Supplemental Environmental Impact Statement (DEIS) for this Prototype Oil Shale Leasing Program. Your review and comments on the adequacy of the DEIS are invited. Please direct your written comments to the Oil Shale Projects Team Leader, BLM, White River Resource Area, P.O. Box 928, Meeker, Colorado 81641. Also use this address when requesting further information on materials referenced in the DEIS.

Public meetings on the DEIS will be held as follows:

August 24, 1982	Denver	Ramada Inn Foothills 11595 W. 6th Ave. 2:00 P.M.
August 25, 1982	Meeker	Fairfield Center 200 Main Street 7:00 P.M.
August 26, 1982	Grand Junction	Ramada Inn 718 Horizon Drive 7:00 P.M.

Written comments received by September 7, 1982, and comments presented at the public meetings, will be fully considered and evaluated in preparation of the Final Environmental Impact Statement (FEIS). Those comments that pertain to the adequacy of the impact assessment, or present new data, will be addressed in the FEIS.

If changes in the FEIS in response to comments are minor, the FEIS will include only those changes and will not be a reprint of the entire DEIS. For this reason, reviewers are requested to retain their copy of the DEIS for use in conjunction with the FEIS volume.

State Director

DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

FOR THE

PROTOTYPE OIL SHALE LEASING PROGRAM

Prepared by

BUREAU OF LAND MANAGEMENT

U.S. DEPARTMENT OF THE INTERIOR

STATE DIRECTOR

COLORADO STATE OFFICE

SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

for the

PROTOTYPE OIL SHALE LEASING PROGRAM

Draft (X) Final ( )

The United States Department of the Interior, Bureau of Land Management

1. *Type of Action*: Administrative (X) Legislative ( )

2. *Abstract*: The Secretary of the Interior proposes to offer for lease one or two additional prototype oil shale leases in the Piceance Basin, northwestern Colorado to supplement the Department's existing prototype oil shale leasing program. The environmental and socioeconomic impacts of the following alternatives are analyzed in this EIS: leasing Tract C-11 only, leasing Tract C-18 only, leasing both Tract C-11 and C-18 (Combined Alternative), and a No Action Alternative. This document supplements the 1973 Prototype EIS. If leased, the additional tract(s) would provide the opportunity for the extraction of oil shale concurrently with associated minerals, as well as for development of other appropriate technologies, more completely fulfilling the original goals of the prototype program. The impact analysis shows that, generally, most adverse impacts reach significance when compounded by developing two leases. If one lease is offered, Tract C-18 will have marginally fewer impacts than Tract C-11; and some impacts would occur under the No Action Alternative from existing, ongoing development.

3. *Comments have been requested from the following*: See Attached List

4. *For further information, contact*:

John Singlaub, Team Leader

Bureau of Land Management

White River Resource Area

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Meeker, CO 81641

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5. Comments on the draft statement must be received no later than:

September 7, 1982

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Western Rio Blanco Parks and Recreation District
Eastern Rio Blanco Metropolitan Recreation and Parks District
Associated Governments of Northwest Colorado

OTHER ORGANIZATIONS AND INDIVIDUALS

Numerous organizations and individuals expressing interest in the proposed action have been sent copies of this statement and have been invited to comment.

TABLE OF CONTENTS

SUMMARY

SUMMARY

Proposed Action

The Secretary of Interior proposes to offer one or two additional prototype oil shale tracts in the Piceance Basin of northwest Colorado.

This environmental impact statement examines the environmental and socioeconomic impacts that would result from that proposed action. The purpose of this document is to assist the Secretary of Interior in making a decision on whether or not to hold a lease sale in March 1983, and if one is held, which tract(s) to offer. It supplements the *1973 Prototype Environmental Impact Statement*, updating environmental data which has become available since that time, and analyzing the impacts of leasing an additional tract that was not included in that document.

Alternatives Addressed

A total of four alternatives are examined in the Environmental Impact Statement: the No Action Alternative, the C-11 Alternative, the C-18 Alternative, and the Combined Alternative. These alternatives are based on tracts of land for which interest has been expressed by industry. Only two tracts (C-11 and C-18) are analyzed. The No Action Alternative examines the impacts of development that may occur without tis leasing. The C-11 Alternative analyzes the impacts of leasing only Tract C-11. The C-18 Alternative examines the effects of leasing only Tract C-18. The Combined Alternative analyzes leasing both C-11 and C-18. The location of these proposed tracts is shown in Figure S-1. Several kinds of development technology may be used to extract the shale oil and other resources. Three generalized, but reasonable development scenarios have been identified to cover the range of potential technologies on each tract. Any of the three kinds of development could occur on either tract.

The scenarios are: **direct mining and surface retorting** of the saline zone by room-and-pillar, chamber-and-pillar, sublevel stoping, crater retreat or similar methods; **mine assisted in-situ** which involves mining and surface retorting of a portion of the resources, and in-situ retorting of the remaining oil shale; and **true in-situ** processing which involves leaching away soluable minerals such as nahcolite, then retorting the shale oil in place by circulating a heated working medium such as gas, superheated water, or steam.

Once any of these methods of processing the saline zone resources is completed, it would be possible to recover oil from upper zone shales by either direct mining or mine assisted in-situ methods.

Regardless of which development scenario would occur, the Environmental Impact Statement analyzes two reasonable levels of production: 25,000 barrels per day and 50,000 barrels per day for each tract, and a 50,000 to 100,000 barrels per day total production rate if both tracts are leased.

Alternatives that were considered, but eliminated from further study included: offering more than two leases, offering tracts larger than 5,120 acres, analyze other areas outside the tracts offered for expressions of interest, intertract bidding, analyzing other areas where interest was expressed but were not delineated as tracts, and delaying the lease sale beyond the proposed March 1983 lease sale date. A description of these proposals and why they were eliminated from further consideration is included in Chapter II. No other alternatives were presented that would have fewer apparent impacts, or that would better meet the Department of Interior's goals for the prototype program.

Conclusions

The results of the impact analysis, focusing on the critical environmental elements that will be affected under the No Action and development alternatives are discussed below.

No Action Alternative

In order to study the environmental consequences of any of the leasing alternatives, a baseline was constructed as a hypothetical starting point for measuring impacts. This baseline includes all of the development and land uses reasonably anticipated for the region in the foreseeable future. The specific projects included in this baseline are identified in Chapter II, No Action Alternative. It should be understood that every attempt was made to describe a reasonable baseline so that impacts predicted for the development alternatives would not be exaggerated or underestimated. Some of the major projects assumed for baseline purposes include: the Colony project near Parachute that suspended operations while this document was being prepared; prototype oil shale tracts C-a and C-b

that have both significantly slowed development, but that are anticipated to resume operations; Union, Mobil, Chevron and other private oil shale operations in the Grand Valley that are anticipated to continue forward with their current plans.

The critical environmental elements affected under the No Action Alternative include socioeconomic and air quality impacts to Rifle and other communities in the Grand Valley. Figures S-2 through S-4 show the average annual percent population growth rate of Meeker and Rifle, Colorado, predicted for the No Action Alternative and for the development alternatives. Between 1983 and 1988, the City of Rifle is anticipated to grow at an average annual compounded rate of approximately ten percent even without additional prototype leasing. Meeker would grow at approximately five to seven percent per year during the same time period. If these predictions hold true, it is likely that Meeker could sustain such a growth rate without serious social and economic hardship. However, Rifle would be approaching the point where social-structural breakdowns in a community could begin to occur (around 10 percent).

Rifle is more significantly affected in this model since it is closer to the private oil shale developments anticipated to take place in the Grand Valley. Variations in this baseline (such as a total Colony or Union shutdown) could significantly affect this rate of growth in the No Action Alternative, and therefore, would affect the significance of impact of the development alternatives.

Air quality near Rifle, east of the powerplant proposed near Mack, Colorado, and within Mt. Zirkel Wilderness Area (see Figure III-1), is also anticipated to deteriorate by the year 2003 under the No Action Alternative. The most significant problems identified by the air quality model are probable violations of the primary National Ambient Air Quality Standards for total suspended particulates (TSP), sulfur dioxide (SO_2) and nitrogen oxides (NO_x) near Rifle. As a result of the private oil shale development predicted for the area west of Rifle, that town will achieve maximum 24 hour concentrations of NO_x in the range of 4100 micrograms/cubic meter, significantly above the annual average primary health standard of 100 micrograms/cubic meter. TSP levels are predicted to be 704 micrograms/cubic meter and SO_2 levels are predicted to be 865 micrograms/cubic meter, both well above the primary health standard of 260 and 365 micrograms/cubic meter, respectively. The Book Cliffs area would attain 329 micrograms/cubic meter of NO_x if the Southwest Power Plant is constructed as proposed near Mack, Colorado.

Since these primary standards are based on health factors, these violations could pose significant health problems for the population of Rifle if development occurs as predicted.

Prevention of Significant Deterioration (PSD) standards would be violated also. Maximum 24 hour concentrations of SO_2 would be 10.1 micrograms/cubic meter in Mt. Zirkel Wilderness Area exceeding the Class I incremental standard of 5 micrograms/cubic meter. Maximum 24 hour concentrations of SO2 at the Book Cliffs would be 147 micrograms/cubic meter, well above the Class II increment standard of 91. Table IV-2 in Chapter IV, Air Quality, details these predicted impacts.

The decision maker should be aware that these levels are predicted based on anticipated private development in the region and, due to topographic and atmospheric conditions, would not change under any of the development alternatives.

Development Alternatives

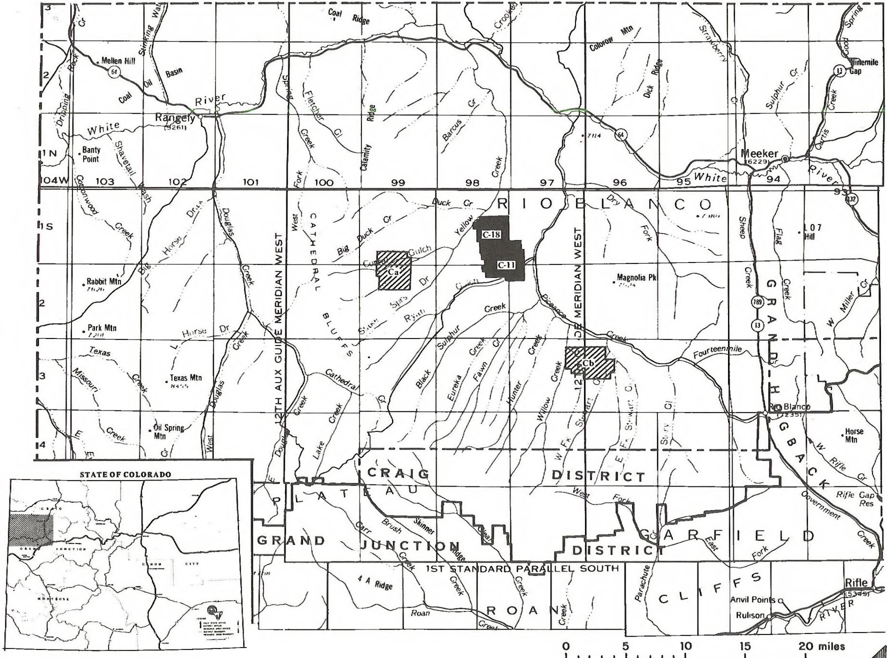
The analysis of the environmental consequences of leasing indicates that a number of significant impacts would occur under all of the development alternatives. In most cases, impacts will vary by development scenario and production rate, rather than by the tract leased. In general, the higher the production rate, the more employees, product transportation needs, surface disturbance, and their resulting impacts, would occur. The different development scenarios create impacts that vary by the resource that is affected. These impacts are described in detail in Chapter IV, Environmental Consequences.

Total estimated in-place reserves of shale oil, nahcolite and dawsonite for each of the two tracts are similar, as shown below:

Lease Tract	Shale Oil	Nahcolite	Dawsonite
C-11	9.2 bill. bbls	3.8 bill. tons	920 mill tons
C-18	10.2 bill. bbls	4.1 bill. tons	1 bill tons
Total	19.4 bill. bbls	7.9 bill. tons	1.92 bill tons

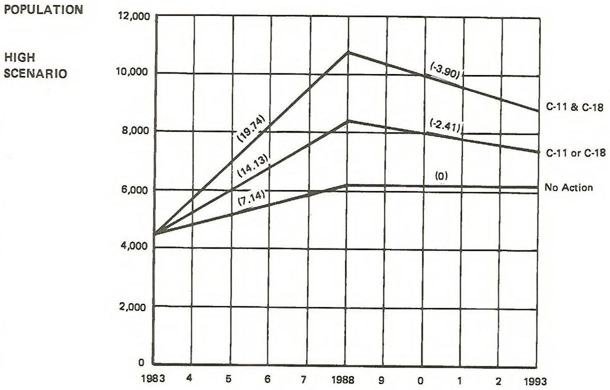
For purposes of comparison, the estimated in-place shale oil resource on only one of these tracts is approximately equal to the proven oil reserves on the North Slope of Alaska. The important variable, however, is the amount of this resource that can be recovered using known methods of mining and retorting. Using currently proven methods of shale processing, up to 20 percent of this shale reserve could be recovered. New technologies could significantly improve this recoverability rate, however, none have successfully been proven to date. It is felt that there is not enough difference in reserves between the two tracts to favor one tract or the other. Production from either tract could conceivably continue at a rate of 25,000 or 50,000 bbls/day for up to 100 years.

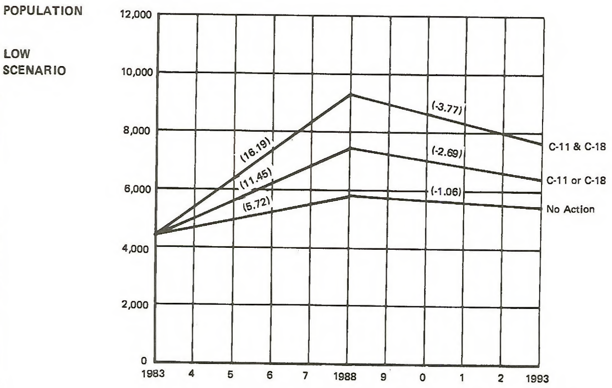
If the decision is made to lease only one tract, there are advantages and disadvantages associat-



Location Map

Figure S-1 Location of Proposed and Existing Prototype Oil Shale Lease Tracts in Colorado





NUMBERS IN PARENTHESIS ARE THE PERCENTAGES OF ANNUAL GROWTH RATES FOR 1980 - 1988 and 1988 - 1993

Figure S-2 Predicted Population Growth Including Incremental Percent Annual Increase by Alternative for Meeker, Colorado

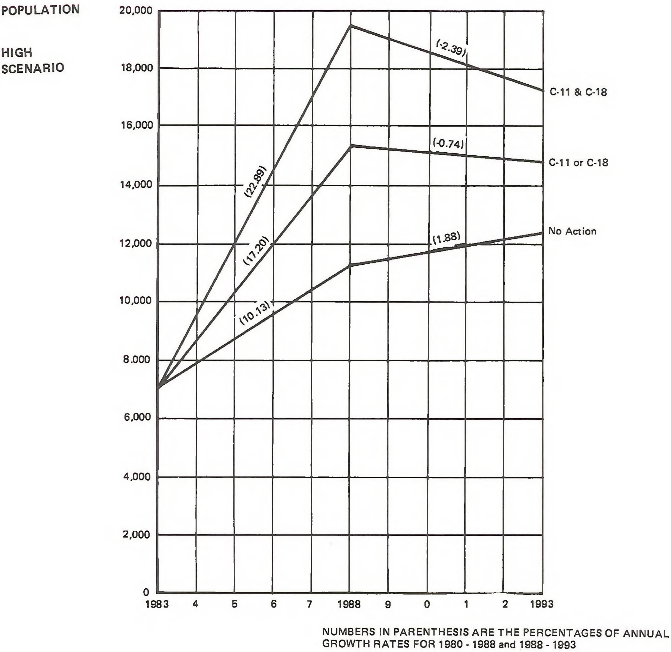
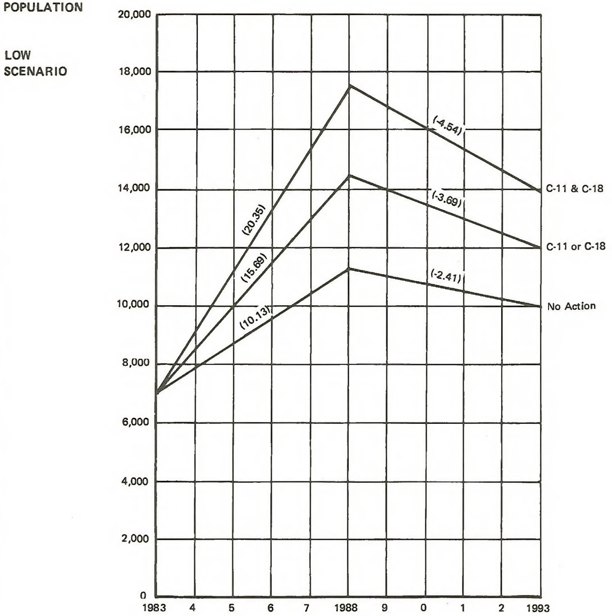


Figure S-3 Predicted Population Growth Including Incremental Percent Annual Increase by Alternative for Rifle, Colorado



NUMBERS IN PARENTHESIS ARE THE PERCENTAGES OF ANNUAL GROWTH RATES FOR 1980 - 1988 and 1988 - 1993

Figure S-4 Predicted Population Growth Including Incremental Percent Annual Increase by Alternative for Rifle, Colorado

ed with leasing either C-11 or C-18. Tract C-18 would be easier to develop and to reclaim than C-11, since the topography is more gentle, there is more available topsoil for covering spent shale disposal piles, and there are more north-facing slopes. C-11 is dissected by drainages dipping into Ryan Gulch, containing steep sideslopes with a southern exposure. Less erosion and faster reclamation would occur on C-18, thereby benefitting livestock forage and wildlife habitat which would be more quickly replaced.

Tract C-11 contains alluvial valleys and floodplains that could be potentially affected, whereas C-18 does not. C-11 has considerably more critical deer winter range than C-18, and more known raptor nests. On the other hand, the density of cultural sites is greater on C-18 than on C-11.

Most of Tract C-18 is presently encumbered by a sodium lease and an approved nahcolite recovery mine plan. Prior to any oil shale leasing on this tract, an agreement would have to be developed between the current sodium lease holder and the government, that would assign the sodium lease to the successful bidder. It is assumed that development of this mine will occur simultaneously with oil shale if C-18 is leased, and independently (sodium minerals only) if C-11 is leased. This situation would result in generally fewer socioeconomic, transportation and surface disturbance-related impacts under the C-18 Alternative than under the C-11 Alternative. On the other hand, C-11 is unencumbered by a sodium lease, presumably making it easier to lease and develop that tract than C-18.

Tract C-11 includes the Bureau of Mines Research Facility at Horse Draw, that may or may not be an advantage to a potential developer. C-11 also contains more public water reserves and existing pipelines than C-18, which may be affected by development of Tract C-11.

The critical elements that should be taken into consideration by the decision-maker prior to leasing additional prototype tracts, include air quality, hydrology, socioeconomics and transportation. These elements and the factors to be considered are described below.

As previously stated, air quality would deteriorate significantly in Rifle, near the Book Cliffs, and within Mt. Zirkel Wilderness Area under the No Action Alternative. These areas would not be further impacted by any of the development alternatives. No additional air quality violations are predicted to occur if only one tract is leased. However, if both tracts are leased at 50,000 bbls/day each, a violation of the PSD Class I increment standard (5 micrograms/cubic meter) in the Flat Tops Wilderness Area east of Meeker is predicted, reaching a maximum 24 hour concentration of 9.4 micrograms/cubic meter for sulfur dioxide. In addition, local air pollution episodes would be more severe on Tract C-11 due to topographical influences; frequent temperature inversions and drainage winds are likely.

Water quality and supply problems would occur under all of the development alternatives. The location of the two tracts is one of the worst places in the Piceance Basin in terms of water impacts, since they straddle two stream basins (Yellow Creek and Piceance Creek). Mine dewatering would affect groundwater supplies in both streams, regardless of the alternative selected, more or less proportionately with the rate of production. How this dewatering is done and how and where reinjection occurs will determine the success of balancing the groundwater system.

Two principal groundwater quality problems have been identified, and are associated principally with any kind of in-situ retorting: contamination from leaching of flooded retort chambers, and aquifer mixing. Leaching of flooded retort chambers could be the most serious problem, since control of retort process contaminants is difficult to achieve underground. The contaminants most likely to increase are pH, sulphates, sodium, hydrogen carbonate, carbonates, and certain organics. The impacts from these pollutants are highly site-specific and vary greatly with local hydrology. Movement of the contaminants through the groundwater system may take centuries since groundwater movement is slow.

Mixing of aquifers could be critical in the lease tract area because the lower aquifer has much higher salinity levels than the upper aquifer. Mine dewatering will cause movement of upper aquifer water into the lower aquifer. Mixing will also occur after the mining operation has ceased and the Mahogany Zone has been extracted, effectively removing the impermeable stratum separating the two aquifers.

Surface water supply impacts were also modeled. Predictions show that reductions in the flow of the White River would amount to about four percent at a production rate of 100,000 bbls/day, a relatively insignificant amount except that this water would be lost to other uses such as agriculture. Of more significance is the reduction in flow in Yellow and Piceance Creeks resulting from mine dewatering. Piceance Creek could begin experiencing periods of no flow, and Yellow Creek could remain dry for more than 50 percent of the time. These affects could be mitigated by water reinjection, however, the success of such a program is still unproven.

Population increases will occur with additional leasing, creating severe socioeconomic impacts to the communities of Rifle and Meeker, if the base-

line impacts identified for the No Action Alternative occur as described above. Total populations could increase at an annual rate of 15 to 17 percent between 1983 and 1988 in Rifle if only one tract is leased, and from 20 to 23 percent per year if both tracts are leased (see Figures S-3 and S-4). This range could create very severe social structural breakdowns for the community.

Meeker would not be as severely affected, as shown in Figures S-2. Leasing one tract could result in annual population increases of 11 to 14 percent from 1983 to 1988. Leasing both tracts would increase that rate of growth to 16 to 20 percent annually, potentially creating some severe breakdowns in the community's ability to cope with growth. Other communities in the region would also be affected but are not predicted to reach these growth rates.

It is evident that the key to these predictions is the actual growth that will take place without additional leasing. The decision-maker is encouraged to examine development potential of private oil shale projects in the region prior to offering additional tracts for lease, and subtracting their incremental contribution to the No Action Alternative constructed here.

The analysis shows a significant increase in vehicular traffic on Piceance Creek Road and State Highway 13 to Rifle as a result of any development alternative. If all products anticipated from the direct mining or mine assisted in-situ scenarios are shipped from the proposed lease tract by truck to market or the Rifle railhead, 1,000 to 2,000 additional trucks would be using these road segments daily, even if only one tract is leased. These numbers would double if two tracts are leased. These levels are so high that it becomes clear that alternative methods of product transportation would have to be constructed. Depending on the form these products take (liquid or solid), pipelines and railroads will have to be considered by the lessee in the future. The impacts of these alternative transportation methods have not been examined in this document, but are recommended as potential mitigation methods.

While a number of trade-offs must be considered in determining which of the two tracts would be more desirable to lease, it is very clear that leasing both tracts would have the most impacts. Due to their proximity to one another, environmental and socioeconomic impacts are compounded under the Combined Alternative, in some cases resulting in severe impacts.

CHAPTER I

PURPOSE AND NEED FOR ACTION

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Introduction and Background of the Prototype Program

The Resource

The oil shale deposits of the Green River Formation occur in several geologic basins in Colorado, Utah and Wyoming. Although much of the oil shale resources contained in these basins cannot be recovered with current technology, estimated economically recoverable reserves could satisfy the United States' oil needs well into the 21st century.

Approximately 72 percent of the land, overlying 80 percent of the oil shale resource, is managed by the Bureau of Land Management. Most of this Federal land is located near the depositional centers of these basins containing the richest deposits.

The Piceance Basin of Colorado is the richest of these basins, and is one of the richest single oil shale deposits in the world. In an area of some 1,500 square miles, well over a trillion barrels of shale oil are estimated to occur.

It is important to recognize that the oil shale in the basin is of high quality, it is concentrated in a relatively small area when compared to oil shale deposits elsewhere in the world, and that the majority of the richest deposits are federally administered. The quality and availability of the oil shale resource and the other associated minerals in the Piceance Basin is discussed in more detail in Chapter III, Geology.

Leasing

Attempts to recover shale oil in the Piceance Basin have met with varying degrees of interest and success since the early 1900's. The Mineral Lands Leasing Act of 1920 enabled the Secretary of Interior to lease oil shale on Federal lands, provided that no lease tract exceeds 5,120 acres, an annual rental of 50 cents per acre is assessed, and that no individual or firm can hold more than this total acreage under lease in the United States. Except for these provisions, the Secretary was given broad discretion to select lease tracts and develop lease terms.

It was not until the early 1970's, however, that a leasing program was developed and oil shale leases were actually sold. In 1971, the Prototype Oil Shale Leasing Program Statement was released, and industry was requested to submit lease tract nominations. Twenty tracts were nominated: 13 in Colorado, 4 in Utah, and 3 in Wyoming. The Department of Interior designated six of these tracts to be offered for lease -- two in each of the states. On April 30, 1973, the Final Environmental Impact Statement (EIS) for the Prototype Oil Shale Leasing Program was released, and the lease sale was held in early 1974. That document, referred to here as the *1973 Prototype EIS*, examined the regional impacts of oil shale development, as well as the site specific impacts of leasing the six tracts. Each of the other potential lease tracts nominated by industry were given only brief treatment in the *1973 Prototype EIS*.

The history of Federal oil shale leasing is discussed in detail in *An Assessment of Oil Shale Technologies Volume II* (Congressional Office of Technology Assessment 1980).

Objectives of the Prototype Program

The goals of the Federal Prototype Oil Shale Leasing Program were established in 1973 by the Secretary of Interior. They are:

1. to provide a new source of energy to the Nation by stimulating the development of commercial oil shale technology by private industry;

2. to ensure the environmental integrity of the affected areas and at the same time develop a full range of environmental safeguards and restoration techniques that will be incorporated into the planning of a mature oil shale industry, should one develop;

3. to permit an equitable return to all parties in the development of this public resource; and

4. to develop management expertise in the leasing and supervision of oil shale development in order to provide the basis for future administrative procedures.

The initial Prototype Program was designed with the concept that six lease tracts in three states would be developed with significantly different mining and processing technologies, and that commercial-scale production of about 250,000 barrels per day (bbls/day) would be achieved by 1980. However, the Wyoming leases were not sold, and development of the Utah tracts was suspended due

to legal ownership questions. Development has only recently resumed in Utah, postponing production plans by several years.

Existing Leases

The four leases issued under the prototype program are called U-a and U-b in Utah, and C-a and C-b in Colorado. The Utah tracts are in the early stages of development of access preparatory to sinking mine entries.

Colorado lease Tract C-a, held by the Rio Blanco Oil Shale Company, originally proposed an open pit mine with aboveground retorting. They planned to dispose of the processed shale off-tract. Subsequent to leasing, the Department of Interior determined that it lacked adequate authority to lease surface use of off-site lands. C-a then switched to an experimental modified in-situ process which was successfully tested in 1981-1982. However, it was determined that the original open pit mining proposal would provide for a more economic return and more efficient recovery of the resource. Further development at C-a is now nearly at a standstill in anticipation of pending legislation permitting offsite disposal of processed shale.

Tract C-b is leased to the Cathedral Bluffs Shale Oil Company. They originally proposed an underground mine with aboveground retorting. As development progressed, it was discovered that the shale may be too fractured to allow for the extraction of economic quantities of oil shale. Their plans were then changed to a modified in-situ process. C-b has also significantly slowed development operations while reevaluating engineering feasibility and awaiting improved economic conditions.

Need for Additional Prototype Leasing and the Proposed Action

The objectives of the prototype program have only been partially realized. Since modified in-situ development, underground mining with aboveground retorting, and possibly open pit mining are the only technologies to be elected for use under the program, additional leasing would be required to ensure that all available technologies for oil shale are adequately tried. Specifically, two kinds of development have been suggested: true in-situ processing and mining associated minerals concurrently with oil shale.

As discussed above, the original intent of the prototype program was to lease six tracts as assessed in the *1973 Prototype EIS*. Since no bids were received on the Wyoming tracts offered for sale in 1974, a total of only four tracts have been leased.

With this in mind, in November 1981, the Assistant Secretary of Interior for Land and Water Resources directed that the Bureau of Land Management provide for offering one or two additional tracts under the prototype program by early 1983. (This is the proposed action of this document.) If feasible, these lease offerings would provide the opportunity for development of oil shale concurrently with associated minerals as well as other appropriate technologies, in an effort to fulfill the original goals of the prototype program.

This program was begun in February of 1982 with the issuance of a Call for Expressions of Interest which was published in the *Federal Register*. The results of this call and the identification of tracts to be assessed is described in Chapter II.

Purpose of the Document

Major Federal Action

Once the decision was made to pursue additional prototype leasing, it was clear that the impacts of offering up to two additional tracts in Colorado were not sufficiently covered by the analysis in the *1973 Prototype EIS*. It was determined that additional prototype leasing would be a major Federal action requiring the preparation of an Environmental Impact Statement under the requirements of the National Environmental Policy Act of 1970. This EIS will address the environmental and socioeconomic impacts of leasing up to two additional prototype oil shale tracts.

This EIS will assist the Secretary of Interior in coming to a decision on whether or not to offer additional leases, how many, and which one(s) to lease.

Relationship to Other Documents

This EIS is being prepared within the context of other land use and resource management decisions, as well as within a framework of concurrent oil shale decisions. Several associated documents

are described below that relate to this EIS and are referenced in the text.

1. 1973 Final Environmental Statement for the Prototype Oil Shale Leasing Program -- The *1973 Prototype EIS* was prepared to examine the regional effects of establishing the Prototype Oil Shale Leasing Program, and to look at the site specific impacts of leasing six particular tracts. This EIS is a supplement to the 1973 EIS since it is examining the site specific impacts of leasing up to two additional prototype tracts under the original program.

This EIS will reference the 1973 document where appropriate, however, significant changes in environmental laws and regulations have occurred in the intervening years, requiring a more comprehensive analysis. In addition, more accurate environmental and socioeconomic data has recently been made available that was not used in the 1973 EIS. Although this is a supplemental EIS, it is structured as a complete and comprehensive analysis that is intended to stand on its own where necessary as a site-specific EIS.

2. Environmental Impact Statement on the Federal Oil Shale Management Program -- The Bureau of Land Management is in the process of developing a long-term oil shale leasing program for proven development technologies on Federal lands. The associated Environmental Impact Statement for that program is being prepared concurrently with this EIS, and is referred to here as the Programmatic EIS. The Programmatic EIS will look at the regional impacts of implementing the leasing program on a three state area (Colorado, Utah and Wyoming). For Colorado, it is using much of the same baseline information and assumptions as this EIS is using. To avoid duplication between the two documents, some referencing of the regional analysis is made in this EIS. While the scope of the two EISs is significantly different, every attempt has been made to be consistent where analysis overlaps.

3. White River Resource Area Management Framework Plan -- The Management Framework Plan (MFP) is the land use and resource management decision document that identifies the framework within which resources will be managed in the White River Resource Area. The central Piceance Basin has been identified as having priority for the development of oil shale, with several specific tracts (including Tract C-11), that were delineated in the *1973 Prototype EIS* and proposed for future oil shale development. The other tract being analyzed in this EIS, C-18, is part of an existing sodium lease. The MFP stresses the need for the concurrent development of oil shale with sodium minerals to maximize the economic recovery of leasable minerals while minimizing the environmental effects of extracting them.

Therefore, leasing of either or both of these tracts is in conformance with the existing MFP. A number of stipulations and mitigation measures are included in the MFP to protect other resource values. These measures and other portions of the MFP are referenced in this document.

The Leasing Process

The Lease Sale

Once the Final Environmental Impact Statement is released, the Secretary of Interior will make the decision on whether or not to move forward with the preferred alternative. The Secretary's decision will have been made with the advice and recommendations of the Regional Oil Shale Team. The Regional Oil Shale Team is comprised of representatives of the governors of Colorado, Wyoming and Utah, and the BLM State Directors of those states. The decision, including any justifications or background material necessary to support that decision, will be issued in the form of a "Decision Document". The decision document will specify the actual lease sale date, which is tentatively scheduled for March 31, 1983. A lease sale notice will be published in the *Federal Register* at least 30 days prior to the sale.

Should a decision be made to lease these additional prototype tracts, operations would proceed under the terms of a lease designed to achieve the objectives identified in "Introduction and Background" (Chapter I, above). To achieve this goal, an interlocking set of bonus, royalty, bonding and performance provisions have been developed and are in the proposed lease located in Appendix A of this document. Some of the key elements of the lease are summarized below.

The Lease

The primary lease term is for 20 years and as long thereafter as there is production in commercial quantities. Readjustment of royalty and operating terms may be made at the end of each 20 year period, although the royalty is adjusted regularly by an index factor to reflect regional oil and gas prices derived from the Producers Price Index. Annual rental of 50 cents per acre per year for the use of the land will be charged as required by the Mineral

Leasing Act of 1920, as amended, and is creditable against royalties.

Royalty is money due and payable to the lessor for the removal of the resource from the leased lands by the lessee. The royalty rate for shale oil under this prototype program would be 12 cents for each ton of oil shale mined for processing that contains 30 gallons for shale oil per ton of material. Under the proposed lease, this rate would be adjusted, depending on the actual oil content of the mined material and the market value of locally produced liquid hydrocarbons with the base year of 1974. Additional royalty would be collected on minerals other than shale oil produced under the lease.

To encourage development and avoid long delays in shale oil production from the leases, payment of minimum royalties will be required whether or not there is actual production. Beginning in the sixth lease year, the minimum royalty payments will be based on production rates derived from the estimated recoverable oil shale reserves contained in each tract. The required minimum royalty payment will increase each year through the 15th lease year and then remain the same through the 20th year at which time the lease terms may be readjusted.

Early production incentives are also provided which will permit, under certain circumstances, the credit of a portion of development costs incurred during the early years of a lease against bonus and royalty payments due the government.

This is only a summary of a portion of the lease itself. The proposed lease and the socioeconomic and environmental stipulations required of the lessee are contained in Appendix A. Provisions of the lease will be referred to throughout this document, so the reader should be familar with both the lease and the associated environmental stipulations.

Required Authorizations

Prior to any actual development of the tracts, a detailed development plan must be submitted and approved by the Minerals Management Service. At that time, the Department will have the opportunity to impose any additional controls and mitigation measures which appear necessary. Approval of the Detailed Development Plan is contingent upon the lessee adequately meeting all environmental requirements and compliance with the National Environmental Policy Act.

After lease issuance and before the submission of a development plan to the Minerals Management Service which will provide for operations other than exploratory operations on the leased tract, the lessee will be required by lease stipulations to obtain at least one full year of initial baseline environmental data against which the actual environmental impact of the proposed development will be measured.

The collection of baseline data and specific parameters to be measured as part of a monitoring program will be integral parts of the detailed development plan to be prepared before the third anniversary of the lease. These plans must provide for compliance with all of the established environmental criteria and receive Departmental approval prior to the start of operations. They must include detailed projected analyses of the amount and types of expected waste materials, the location and extent of the disposal areas, the types and amount of vegetation that will be used in land restoration, and adequate assurance to the Department that the lessee has designed the disposal restoration systems to protect the long run productivity of the affected areas. These plans will be subject to public hearings conducted by the Department on the environmental aspects of the proposed operations. Only after such hearings and consultation with State and local officials may the plans be approved, and then only after the Minerals Management Service with Bureau of Land Management concurrence is satisfied that all lease terms, stipulations and provisions will be satisfied.

A bond would be required as security to ensure that the approved development restoration plan would be conducted in a manner designed to minimize degradation of the environment and that all other related lease terms would be met. The bond would be for not less than $4,000 per acre of land to be involved in actual mining operations or spent shale disposal and not less than $1,000 per acre for all other portions of the leased land that would be affected during the first three year period of operation. The total bond shall, in no event, be less than $40,000. Bonds for subsequent periods would be in sufficient amounts to provide for reclamation and restoration of disturbed lands.

In addition to the detailed development plan, the lessee is responsible to obtain all applicable Federal, State and local permits and authorizations associated with the mine and ancillary facility development. The State of Colorado indicates that this may involve obtaining more than 100 permits to build and operate an oil shale plant (Colorado Energy Research Institute 1981). An effort has been made by the State of Colorado to streamline this permitting process for industry by establishing a Joint Review Process. This is a voluntary program involving the cooperation of all affected agencies in an effort to reduce the cost and workload requirements of the developer and government agencies

in applying for and acquiring permits and other authorizations. In any case, it is the responsibility of the lessee to obtain these permits either independently or through the State's Joint Review Process.

Issues and Concerns

In an effort to determine the scope of analysis of this document, public meetings were held on March 24, 25 and 26, 1982, in Meeker, Grand Junction and Denver, Colorado, respectively. The public was asked to identify their con cerns and the issues that should be addressed in the EIS. These comments were obtained verbally and in writing.

Issues that were identified and which have been addressed in this EIS, are listed first below. These concerns have been summarized and grouped into categories for ease of reference. Additional issues which were raised and are covered by laws or regulations that require their analysis in the EIS, are not included in this listing. Also listed are those concerns and issues that are beyond the scope of this document. Many questions were raised about a permanent oil shale leasing program and about site specific development plans that will be handled in other documents. Those issues that have not been addressed in this document, and the reasons for excluding them from analysis, are listed secondly.

Significant Issues Raised During Scoping and Addressed in this EIS

a. The need to expand the *1973 Prototype EIS* analysis to include a wide range of current environmental knowledge.

b. The analysis should describe the cumulative impacts of additional prototype leasing on top of existing and proposed development in the region.

c. A comparison should be made of energy requirements of different development technologies and the net energy values produced.

d. The conflict between oil and gas recovery and oil shale development should be examined.

e. Air quality impacts, particularly as they affect Class I areas and wilderness areas is a widespread concern. The uncertainties of existing air quality models, control technologies, siting patterns, acid rain, and antici pated population increases are specific concerns related to air quality impacts.

f. Water quality and water consumption problems were identified as significant issues. Specific concerns included salinity, effects of leachates and retort waters, toxicity, water availability for wildlife and agriculture, water reuse and total consumptive use.

g. Legal problems associated with leasing oil shale on an existing sodium lease, where both resources are intermingled, was identified as a concern.

h. Several socioeconomic concerns were presented. Included among these issues are: the need to assess cumulative direct and indirect impacts of population growth, revenue sources and timing, "boom-bust" effects, housing, lifestyle changes, labor requirements and sources, and the need for socio economic mitigation measures.

i. Impacts on game and non-game species of wildlife is a serious concern, both from direct and indirect effects of the oil shale development.

j. Mined land reclamation, stabilization and leaching problems with spent shale and potential soil erosion impacts were identified as concerns.

k. The impacts to the existing transportation systems and the potential for building and financing new transportation were identified as issues. This includes both product transportation needs as well as increased demand on highways due to workers and increased populations.

Issues Raised During Scoping But Not Addressed in this EIS

a. Several concerns were raised regarding the need for additional prototype leasing at this time. Specific concerns were that baseline monitoring of existing prototype leases should be completed prior to additional leasing; the questionable demand for shale oil; and that the prototype program has served its purpose and that the Department of Interior should be concentrating its efforts on a permanent, long-term oil shale leasing program.

As previously stated, the effort to lease additional prototype tracts is necessary to achieve the original goals of the prototype program. While the Department is moving forward on de-

velopment of a permanent long-term leasing program, it was also felt that extending the opportunity to private industry to test new technology on public lands, in the interim, was in the public interest and within the intent of the prototype program.

b. Some changes to the original prototype lease were recommended, such as adding or deleting certain environmental stipulations, and changing the method for determining royalties and their payment.

Based on BLM's experience to date, it is felt that the leasing process itself, as identified in the existing prototype program, should not be changed. Some of the environmental stipulations in the lease have been fine tuned to correct problems with the original stipulations, but no major changes have been made to the lease. The lease and the stipulations as proposed for this round of leasing are included in Appendix A.

c. Several commentors felt that the technologies to be used for the prototype leasing should be restricted or specified in this document.

The prototype program is intended to stimulate the development of new technologies. This could include any type of concurrent development of oil shale with associated minerals, a true in-situ retort method, or other appropriate development techniques. In order to evaluate potential impacts, a range of realistic development scenarios have been examined that meet the criteria of the prototype program. However, it would be inappropriate to restrict potential development proposals prior to lease sale.

d. It was felt that the fair market value of the resources to be recovered under each development scenario should be identified in this EIS.

The market value will have to be assessed prior to lease sale to evaluate bids and determine minimum acceptable bids. However, it is felt that such a determination is beyond the scope of this EIS.

e. Alternatives to oil shale as an energy source should be examined.

The 1973 Prototype EIS examined other energy alternatives to the prototype program. It is believed that this analysis is still valid.

f. Several issues were brought out regarding the tertiary effects of oil shale development such as impacts from additional power plants, upgrading and refining facilities and secondary industrial development that may be required for an expanded oil shale industry.

These kinds of effects have been identified where possible, but their impacts have not been analyzed. While tertiary development is anticipated, too little is known about the magnitude, location or nature of the development to prepare any meaningful analysis.

g. Concerns were expressed about worker health and safety on the job.

The Environmental Stipulations of the prototype lease, Section 5 give responsibility for the health and safety of workers, and compliance with Federal health and safety laws and regulations to the lessee. Industry's plans to comply with these laws will be contained in the Detailed Development Plan.

h. The need for a Spill Prevention Control and Countermeasure Plan for hazardous wastes and oil spills was identified as a concern.

Again, the Environmental Stipulations of the lease, Section 7 require submission of a spill contingency plan with the Detailed Development Plan. Specific provisions in these stipulations also provide for responsibility for handling, use and storage of hazardous substances.

Baseline Assumptions

In order to assess the cumulative impacts of leasing additional prototype tracts, a baseline had to be established upon which to add the incremental impacts of this leasing. The No Action Alternative (see Chapter II), identifies all existing projects and proposed projects that are assumed for purposes of this baseline. Only those projects that were deemed most likely to be constructed within a reasonable time frame as of April 1982 were included. Thus, both the Colony Oil Shale project and the LaSal pipeline were assumed for the baseline. Both of these projects were put on hold indefinite ly subsequent to construction of this baseline. While this may seem to skew the baseline to reflect more development than will actually occur without additional prototype oil shale leasing, it is not unreasonable to expect these projects or similar ones to come online in the future. Therefore, both Colony and LaSal have been left in the No Action Alternative.

The proposed lease and environmental stipulations included in Appendix A of this document are also assumed for analysis purposes. The mitigation measures proposed in the stipulations are "commit-

ted mitigation." In other words, they are measures within the authority of the Department of Interior to enforce or require. Failure to comply with these stipulations shall be grounds for termination of the lease as described in Section 10 of the lease.

Additional, specific committed mitigation measures that are not included in the environmental stipulations of the lease are as follows:

1. Human disturbances will be restricted within areas designated as critical deer winter range between December 1st and March 31st when definite conflict areas are identified as determined by the mining supervisor. Where necessary, these conflict areas will be posted and closed to protect wintering deer herds.

2. Any land use activity within deer or elk migration routes that would result in an adverse impact and inhibit or defer animal movement, will be prohibited as determined by the mining supervisor.

3. Prohibit any land use activity within an average of 0.25 mile of any active raptor nest that would permanently alter the habitat and adversely impact nest productivity. Actual areas of restriction are variable in size pending topography, raptor species, and on-site inspection. Active raptor nests located during future field surveys or baseline data collection efforts will have a restriction zone identified and managed according to this stipulation, zones presently designated are as follows:

T2S, R97W, 6th PM

Sec. 6: SW1/4NW1/4NE1/4, SW1/4NE1/4, S1/2NE1/4NW1/4, SE1/4NW1/4SW1/4, N1/2NE1/4, NW1/4NW1/4SE1/4.

Exception to this stipulation would be in accordance with the January 3, 1980 *Federal Register* amendment to subpart C of 50 CFR 22 to allow and regulate the destruction or removal of certain nests when: (1) the nests interfere with resource development or recovery operations, (2) the nests are not occupied or under construction, and (3) the taking is compatible with preservation of the species.

4. Prohibit any human disturbance within an average of 0.25 mile of any active raptor nest between March 1 and July 31. Actual buffer zone areas are variable in size pending topography, raptor species, and on-site inspection. Season of restriction is variable dependent upon species of raptor present. Active raptor nests located during future field surveys or baseline data collection efforts will have a restriction zone identified and managed according to the stipulation. Zones presently designated are as follows:

T2S, R97W, 6th PM

Sec. 6: SW1/4NW1/4NE1/4, SW1/4NE1/4, S1/2NE1/4NW1/4, SE1/4NW1/4SW1/4, N1/2NE1/4, NW1/4NW1/4SE1/4.

Exception to this stipulation would be in accordance with the January 3, 1980 *Federal Register* amendment to subpart C of 50 CFR 22 to allow and regulate the destruction or removal of certain nests when: (1) the nests interfere with resource development or recovery operations, (2) the nests are not occupied or under construction, and (3) the taking is compatible with preservation of the species.

5. Additional Endangered Species Act Section 7 consultation with the USFWS will be required prior to approval of the Detailed Development Plan when necessary information on water requirements is available to accurately assess potential impacts to the Colorado squawfish.

6. All trees to be cleared for development will be purchased by the lessee prior to construction, from the Bureau of Land Management, White River Resource Area, and disposed of by the lessee as follows:

All stems, stumps, and branches greater than four (4) inches in diameter shall be: (a) removed from Federal land for resale or for private use; or (b) cut into lengths not exceeding four (4) feet and scattered as directed by the mining supervisor.

All stems and branches less than four (4) inches in diameter shall be disposed of as directed by the mining supervisor.

The existing White River Resource Area Management Framework Plan (MFP) directs the Bureau's activities in the study area. It is assumed that the stipulations and guidelines for development and multiple resource management contained in the MFP will be applied and are also committed mitigation measures. The BLM Manual requirements for particular resource elements are also assumed, and are identified as appropriate in the text. Other specific assumptions are identified where particular resource data is unknown or is widely varied, to facilitate analysis. These assumptions are identified under the applicable resource elements, and are consistent for each resource element throughout the analysis process.

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CHAPTER II

DESCRIPTION OF THE ALTERNATIVES

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Introduction

On February 18, 1982, industry and the general public were asked to indicate any interest they had in additional prototype leasing in the Piceance Basin. The call for expressions of interest asked for specifics on the kind of development technology proposed and the tract that the respondent was interested in. The areas offered included potential lease tracts delineated both in the White River Resource Area Management Framework Plan and the *1973 Prototype EIS*. In addition, the existing sodium lease tracts in the basin were also offered.

A total of 10 responses were received. Six of these were either negative statements, comments on the prototype program in general, or expressions of concern about leasing certain tracts. Four responses were positive expressions of interest on specific tracts, all the development of oil shale concurrently with associated minerals in the Saline Zone. Shell Oil Company proposed an in-situ process to be used on Tract C-11 (as identified in the *1973 Prototype EIS* and referred to as Tract I in the call for expressions of interest). Nielson Resources Corporation proposed in-situ development on the Rock School Corporation Sodium Lease, an area of some 1,320 acres. Industrial Resources, Incorporated expressed interest in the eastern part of the Wolf Ridge Corporation sodium lease tract to use a direct mining and surface retorting process. Multi Minerals Corporation also expressed interest in the eastern portion of the Wolf Ridge sodium lease tract for an intergrated in-situ development process.

Based on these responses, it was determined to identify a maximum of two tracts that are logical mining units not to exceed 5,120 acres each in size for consideration in this document. These two tracts were delineated with the assistance of the Minerals Management Service, Oil Shale Office based on minability and the potential for future development. Further details describing the tracts are included in each alternative below. Tract C-11 was included in the *1973 Prototype EIS* and that designation will be carried on in this document. The expression of interest on the sodium lease tracts were consolidated into a single logical mining unit of 5,120 acres with good access and development potential. This tract is new and will be referred to here as C-18. These tracts are shown on Figure II-1.

For each of these two tracts, Minerals Management Service also described potential, reasonable development technologies that could be used. Since impacts differ depending on how the tract is developed, a range of reasonable development scenarios were identified that can apply to either tract. These development scenarios are referred to in the impact summaries of each alternative, and are described in detail immediately following the alternatives.

The alternatives, are structured as follows: leasing either Tract C-11 or Tract C-18, or leasing both, or not leasing any new prototype tracts at all. These leasing alternatives will be analyzed for a range of reasonable development scenarios as subalternatives. It is assumed for analysis purposes that the prototype lease sale will take place in March 1983 for each of the development alternatives. The four alternatives and the possible development scenarios are described below. The No Action Alternative is discussed first to provide a baseline for activity and resource uses that will occur in the area without additional prototype leasing. Committed mitigation measures that are applicable to all alternatives have been discussed in Chapter I, Baseline Assumptions.

No Action Alternative

General Description

The No Action Alternative would not offer any additional prototype tracts for leasing to augment those which are currently in existence. No new annual production would occur and there would be no further disturbance as a result of additional prototype tracts.

Impacts in the area would occur without additional leasing as a result of existing projects which would continue. Current mineral activity in the region is summarized below. Other resource activities and land uses in the area are described in Chapter III under the appropriate heading.

Existing Mineral Activity

One of the most significant resource activities in the Piceance Basin is mineral development. The following discussion summarizes the major activities currently under development and projected for the near future.

Oil Shale

Oil shale resources in the Piceance Basin are being developed under two existing Federal prototype leases. In addition to these leases there is planning and development of private oil shale holdings in and adjacent to the Piceance Basin.

C-a Tract - Gulf Oil Corporation and Standard Oil Company (Indiana) were the successful bidders for Colorado Tract C-a in 1974 and organized the Rio Blanco Oil Shale Company to effectively develop this tract. During the period 1977-1981 Rio Blanco Oil Shale Company successfully completed a modified in-situ demonstration project which provided information needed to evaluate commercial modified in-situ development of Tract C-a. The study indicated open pit development with surface retorting and offsite disposal of overburden and processed shale would be the most efficient method with respect to oil shale recovery. However, the uncertainties of economics and congressional approval of legislation allowing the Secretary of Interior to lease additional land for overburden and waste disposal off-tract prevents Rio Blanco Oil Shale Company from commencing with commercial scale open pit development at the present time. Finalized development plans incorporating the above mentioned preferred technology are unavailable. Therefore the following assumptions have been compiled as guidelines for impact assessment purposes.

Development scenarios have been formulated by the Programmatic Oil Shale Environmental Impact Statement team based on a production rate ranging from a low of 50,000 barrels per day (bbls/day) to a high of 100,000 bbls/day by the year 2000. For both scenarios construction activities would begin in 1983 with steady-state production levels achieved by 1998. The production expectancy for Tract C-a is 30 years.

For the 50,000 bbls/day development scenario, 1,700 workers would be employed at steady-state production. Approximately 8,000 acre feet of water per year(acre ft/yr) from the White River drainage would be required for project implementation. Total surface disturbance would encompass 3,550 acres: 420 acres at the surface facility site, and 3,130 acres involving disturbances reclaimable within a shorter time period (e.g., product pipeline routes, utility corridors, overburden stockpiles, and spent shale piles).

For the 100,000 bbls/day development scenario, 2,700 workers would be employed at steady-state production. Approximately 16,000 acre ft/yr of water from the White River drainage would be required. Total surface disturbance would encompass 7,100 acres: 840 acres at the surface facility site, and 6,260 acres involving disturbances reclaimable within a shorter time period.

A survey indicates the percentage of employees residing in nearby communities to be Rifle-83 percent, Meeker-13 percent, Rangely-3 percent, and elsewhere-1 percent, if the future situation imitates current conditions. This preference would apply to both scenario levels. Figure S-1 shows the location of Tract C-a.

C-b Tract - Federal Oil Shale Lease Tract C-b was awarded April 1, 1974 and is currently managed by the equal-interest partnership between Occidental Oil Shale Corporation and Tenneco Shale Oil Company, doing business as Cathedral Bluffs Shale Oil Company. Cathedral Bluffs Shale Oil Company submitted a detailed development plan for surface retorting in 1976 followed by a modified plan in 1977 to incorporate modified in-situ retorting. Currently, Cathedral Bluffs Shale Oil Company is re-evaluating present development plans before proceeding into a commercial development phase. Development plans incorporating preferred commercial technology are not available at the present time. Therefore, the following assumptions have been formulated for impact assessment purposes.

The Programmatic Oil Shale Environmental Impact Statement team assumes a year 2003 production rate ranging from a low of 21,000 bbls/day to a high of 76,000 bbls/day. For both scenarios, construction activities would peak at 1985 with steady-state production levels achieved by 1995. The production expectancy for Tract C-b is 30 years. Cathedral Bluffs Shale Oil Company socio-economic assessment surveys estimate future distribution of the permanent work force to be 60 percent in Rifle, 25 percent in Meeker, and 10 percent in Silt, and 5 percent in other locations.

For the 21,000 bbls/day development scenario, 670 workers would be employed at steady-state production. Approximately 8,000 acre ft/yr of water from the White River drainage will be required for project implementation. Total surface disturbance would encompass 1,700 acres: 200 acres at the surface facility site, and 1,500 acres involving disturbances reclaimable within a shorter time period.

For the 72,000 bbls/day development scenario 2,100 workers would be employed at steady-state production. Approximately 12,000 acre ft/yr of water from the White River drainage would be required for project implementation. Total surface disturbance would encompass 5,325 acres: 630 acres at the surface facility site, and 4,695 acres involving disturbances reclaimable within a shorter time period. Figure S-1 shows the location of Tract C-b.

Private Oil Shale Development - Private ownership of oil shale involves the Colony (Exxon-Tosco)

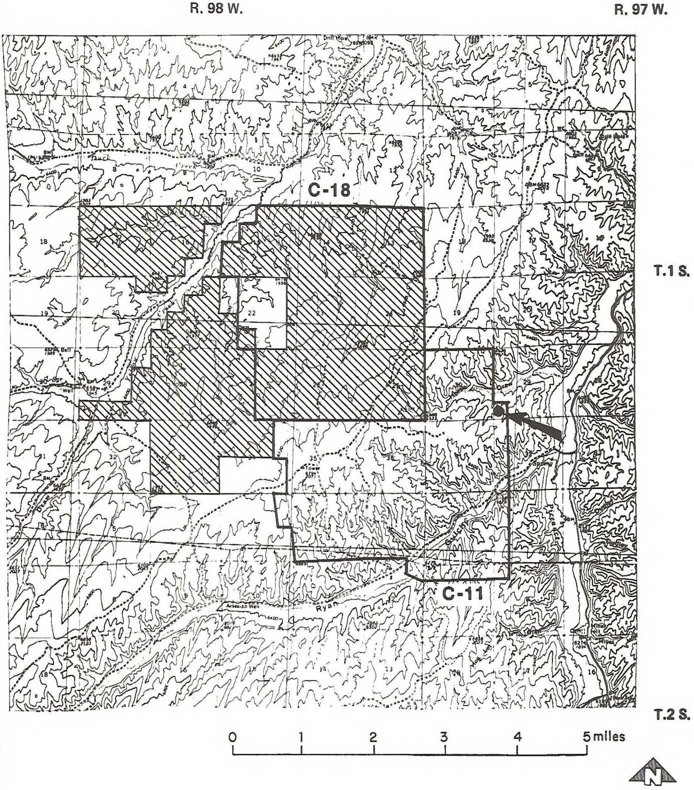


Figure II-1 Tracts C-11 and C-18 Showing Wolf Ridge Corporation's Existing Sodium Lease (shaded) and the Bureau of Mines Horse Draw Facility (arrow)

Aerial view looking northeast across the Piceance Creek Oil and Gas Unit. Disturbances from development of the unit include an airstrip (far right), numerous access roads, well pads (example well lower left), and a gas processing plant (center). June 10, 1982

Aerial view looking north-northeast at pipelines leading to the gas processing plant in the Piceance Creek Oil and Gas Unit. Note the producing well in the lower third of the photo. June 10,1982

Project in Parachute Creek; Union Shale Oil Project also in Parachute Creek; Chevron Clear Creek Project on Clear Creek and Skinner Ridge; Mobil Oil Co. southwest of Anvil Points; and Superior-Pacific west of Rifle, Colorado. Together these projects are anticipated to have the following magnitude of development:

1) Construction of the sites has either started or will have by 1986.

2) Employment will be 2,580 in 1986; 4,280 to 6,530 in 1992; 4,980 to 9,730 in 1993; and 6,880 to 11,720 in 1998.

3) Peak production will range from 63,000 bbls/day in 1986; 73,000 bbls/day to 163,000 bbls/day in 1990; 123,000 to 213,000 bbls/day in 1992; 173,000 to 263,000 bbls/day in 1998; and 213,000 to 303,000 bbls/day in the year 2000.

4) The regional socioeconomic impact monitoring system report of November 1981 by the Colorado West Area Council of Governments estimates the employees (excluding Union) will live in the following communities: Grand Junction 10 percent, Clifton 1 percent, DeBeque 30 percent, Parachute 16 percent, Rifle 14 percent, Battlement Mesa 25 percent, Glenwood Springs 1 percent, Silt 1 percent, New Castle 1 percent, Other and not reported 1 percent.

By county, this would be: Garfield - 58 percent, Mesa - 41 percent, and Other - 1 percent.

Union Oil Company will have 28 percent of their employees (700 to 3,200 total) in Rifle, 19 percent in Grand Junction, 13 percent in Parachute and the remainder on the mine site camp.

5) Water use of the companies will total 11,500 acre ft/yr by 1986; 16,000 to 24,000 acre ft/yr by 1992; and 18,000 to 35,400 acre ft/yr by 1998 from the Colorado River.

6) Total disturbed acres will range from 11,200 to 20,500 acres by the termination of the projects sometime in the year 2016 assuming (30 year life of the mine). Mine plant facilities will occupy approximately 1,670 to 3,020 acres when full production is reached in 1998.

Sodium

Multi Mineral Corporation currently has an approved mine plan for the development of a sodium mine that includes portions of Tract C-18 (see Figure II-1). Three years of mine shaft and support facilities development are expected to begin in the fall of 1982. The mine will be developed by the room and pillar method.

At full production, approximately 177 acres of surface will be disturbed; 15 acres for the plant site, 108 acres for topsoil storage and 3.5 miles of paved access.

At full production, Multi Mineral Corporation will employ approximately 440 workers. Ninety of these employees would be based in Rifle as their nahcolite trucking crew. These crews would make 90 round-trips per day in 26 ton capacity trucks from the mine to the Rifle railhead. The remaining 350 employees will be commuting from Rifle (35 percent), Meeker (50 percent), Rangely (10 percent), and other (5 percent). Water for the mine will be obtained from a well (producing 72,000 gal/day) in the upper aquifer being pumped at 50 gal/min, 24 hours per day. Approximately 36,000 gal/day will be used for potable purposes, the remaining 36,000 gal/day will be used for dust suppression and other activities associated with mining. Total water use will be approximately 81 acre ft/yr. Once the mine is in full production (1985) the expected life of the mine is 30 years (2015).

In addition, the Bureau is currently evaluating three Sodium Preference Right Lease Applications (PRLAs). Two of the PRLAs are located immediately north and east of Tracts C-18 and C-11. It is anticipated that these will be operated as a single mine. The other PRLA is located to the southwest of the tracts, and is expected to develop as a second mine.

Mine development is expected to be the same for both PRLA mines. The following assumptions have been made for purposes of this analysis. Development of the two PRLA mines would occur simultaneously with full production of 227,592 tons of sodium minerals annually for each mine by 1988. Finished product would be trucked to rail facilities at Rifle, Colorado utilizing 26 tons capacity trucks requiring approximately 33 1/2 truckloads per working day for each mine. Each mine would have 72 employees on a 2 shifts/day and 5 day/week schedule. Employees are expected to live in the same communities as the Multi Minerals employees.

Oil shale may not be processed under a sodium lease. Shale recovered during the mining process is considered a by-product and will be stored on the surface at least for the first five years of operation. Processing would produce approximately 228 tons of waste per day, or 59,280 tons annually. Mine life would be in excess of 50 years at stated production levels. Exploration work is expected to begin in 1984 with development of the mines to start in 1985. Approximately 14.5 acres of surface disturbance would occur at each mine for the mine plant sites and shale storage for a total of 29 acres surface disturbance, excluding roads.

Water requirements would be about 13.6 percent of that required by Multi Minerals in their issued sodium lease mine plan or 11 acre ft/yr per mine.

Bureau of Mines Facility

The Bureau of Mines has a research shaft located in Horse Draw on the eastern portion of proposed Tract C-11 (SW1/4, Sec. 29, T1S, R97W) as shown in Figure II-1. The Bureau of Mines has been actively studying mining environmental problems, mitigation and processing tests for concurrent development of oil shale, nahcolite and dawsonite in the lower saline oil shale facies of the Parachute Creek Member of the Green River Formation.

The test shaft site has recently been operated by Multi Minerals Corporation under a cooperative agreement with BLM and the Bureau of Mines. Multi Minerals Corporation has proposed to continue operating the facilities under a new one year agreement with the provision that either Bureau of Mines, the Bureau of Land Management or Multi Mineral Corporation can give a 30 day notification of the cessation of operations. The site is expected to remain on "standby" status until funding for more studies are authorized. Standby status requires only 5 people on the site, principally guards and maintenance personnel.

Oil and Gas

The oil and gas drilling efforts throughout the Piceance Basin are assumed to continue at approximately the current rate in the Sagebrush Hills II, Rio Blanco, Piceance Creek and Yellow Creek Oil and Gas Units. Since all the units are "producing units", at least two wells per unit must be drilled per year for a total of ten wells per year to fulfill unit requirements. Companies like Sun Gas and Rio Blanco Natural Gas are more active and can be expected to drill as many as five to nine wells per year for their units. This means a maximum of 18 wells could be drilled per year. Assuming each drill rig requires approximately 10 to 12 people to operate plus eight support people (water haulers, dirt contractor, roustabouts, company representatives, etc.) and can drill a well on an average of every three months. This means as many as 80 people and four rigs will be operating in a year to drill 18 wells.

Water required for each well drilled is highly variable depending upon size of the hole, type of mud program and water encountered downhole. On a rough average approximately 75.6 gallons (1.8 barrels) of water are used per foot of hole drilled. The average depth of hole drilled is between 8,000 and 12,000 feet. Water consumption per hole then is between 1.86 to 2.78 acre feet of water. For 18 wells, this would amount to some 33.4 to 50.1 acre feet annually.

Well pads will vary from 1.7 to 3.6 acres in size. Access roads will be on the average 25 feet wide and 1.3 miles long. Therefore, the average surface disturbance per well will be between 5.7 and 8.6 acres in size or, for the 18 anticipated wells per year, 102 to 155 acres.

Coal

Coal, although peripheral to Piceance Basin, is being developed in the Ninemile Gap area northeast of Meeker, and the Scullion Gulch area east of Rangely. Northern Coal Company is active in the Ninemile Gap area with coal production planned to reach 3.4 million tons per year from 1987 to 1992. Peak production will be 4.2 million tons per year from 1993 to 2008. Peak employment will be 672 by 1993. Total surface disturbance will be 140 acres. 73 percent of the employees are expected to live in Meeker, with the balance living in Craig and Hayden.

The Moon Lake Power Project is being constructed near Bonanza, Utah. At full production the coal mine near Rangely that will supply the project will produce 2.4 million tons of coal per year that will be transported by rail to Bonanza. Peak production employment in Colorado in 1987 will be 410 employees living primarily in Dinosaur and Rangely. Water use will be 367 acre ft/yr derived from four alluvial wells drilled adjacent to the White River. Total surface disturbance will be 700 acres by 1990 and will reach a maximum of 1000 acres.

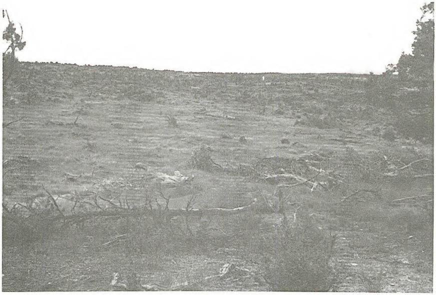
Summary of Impacts

The following impacts would occur even without leasing additional prototype oil shale tracts. This is only a summary of the significant anticipated impacts; a more detailed analysis is included in Chapter IV, Environmental Consequences.

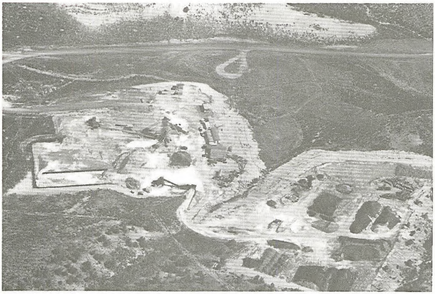
Air Quality -- Air quality in Rifle, along the Book Cliffs northeast of Mack, Colorado, and within Mt. Zirkel Wilderness Areas is also anticipated to deteriorate by the year 2003 under the No Action Alternative. The most significant problems identified by the air quality model are probable violations of the primary National Ambient Air Quality Standards for TSP, SO_2 and NO_x near Rifle in these two areas. As a result of the private oil shale development predicted for the area west of Rifle, that town will achieve maximum 24 hour concentrations of NO_x in the range of 4,100 micrograms/cubic meter, signifi-

Aerial view looking south at drilling and pipeline activity southwest of C-a tract. June 10, 1982

Aerial view looking northwest across modified in-situ test area on tract C-a. June 10,1982

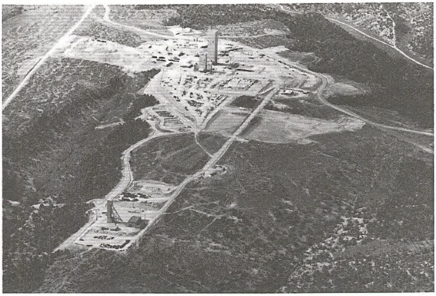


View looking north from the chainings on tract C-11.



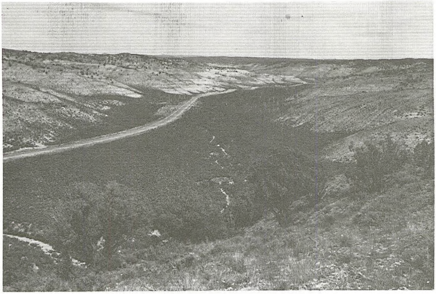
Aerial view looking north across the Bureau of Mines oil shale test facility in Horse Draw. Mine shaft is located in the left center of the photo. June 10, 1982

Aerial view looking southeast across the mine development area on tract C-b. The Production and Service Shaft head frames are the two large structures in the right center of the photograph. June 10, 1982



Aerial view looking south across the mine development area on tract C-b. Ventilation/Escape Shaft head frame is in the lower left corner of the photo. June 10, 1982

Aerial view looking northwest across Piceance Creek and Horse Draw at both tracts C-11 and C-18. June 10, 1982



View looking northeast down Ryan Gulch and the southern exposure (left side of the photo) of tract C-11.

cantly above the primary health standard of 100 micrograms/cubic meter. TSP levels are predicted to be 704 micrograms/cubic meter and SO_2 levels are predicted to be 865 micrograms/cubic meter, both well above the primary health standard of 260 and 365 micrograms/cubic meter, respectively. The Book Cliffs area would attain 329 micrograms/cubic meter of NO_x if the Southwest Power Plant is constructed as proposed near Mack, Colorado. Since these primary standards are based on health factors, these violations could pose significant health problems for the population of Rifle if development occurs as predicted.

Prevention of Significant Deterioration (PSD) standards would be violated. Maximum 24 hour concentrations of SO_2 would be 10.1 micrograms/cubic meter in Mt. Zirkel Wilderness Area exceeding the Class I incremental standard of 5 micrograms/cubic meter. Maximum 24 hour concentrations of SO_2 at the Book Cliffs would be 147 micrograms/cubic meter, well above the Class II increment standard of 91. Table IV-2 in Chapter IV, Air Quality, details these predicted impacts.

Geology -- Nahcolite will be mined on portions of Tract C-18 and could result in the permanent loss of 13.5 million tons (8 million barrels) of oil shale (0.3 percent of the estimated recoverable amount of oil shale).

Oil and gas exploration and production could continue unimpeded and temporarily prevent extraction of 72 percent of the in-place oil shale per acre.

Alluvial Valleys, Floodplains, and Agricultural Lands -- Water quantity and quality in Yellow Creek may be affected, remaining dry 50 percent of the time and having lowered water quality with increases in dissolved solids by 900 mg/l by the continued development of C-a Tract. Impacts upon the floodplain of Yellow Creek are not expected.

Off-tract development such as pipeline routes and utility corridors may temporarily impact agricultural lands. Between 6,770 and 10,160 acres of agricultural land would be permanently impacted from population growth and the associated conversion of agricultural lands to urban expansion.

Soils -- Approximately 20,000 acres of surface disturbance would occur in the region, resulting in an unknown quantity of topsoil displacement and loss of soil productivity. Significance of these impacts would directly correlate to the success of reclamation. Soil impacts would be significant if reclamation is unsuccessful or inadequate.

Hydrology -- Mine dewatering from Tracts C-a, C-b and the Multi Mineral Nahcolite mine may result in a decrease in surface water quality due to decreased flows. Yellow Creek flow would be reduced to 50 percent of normal flow, and occasionally experiencing periods of no flow. Piceance Creek would also experience periods of no flow in the summer months. However water quality of the lower aquifer is expected to improve due to the downward movement of the better quality upper aquifer. As the mines are dewatered, Public Water Reserves and springs on and within the vicinity of the lease tracts may be impacted resulting in shifts in livestock and wildlife useage. Once dewatering ceases water levels within the lease tract area would be expected to return to near premining conditions with the possible exception of springs and Public Water Reserves.

Vegetation -- Under this alternative, loss of vegetation on 20,000 acres would occur and result in the temporary loss of 1,500 AUMs of forage for use by livestock and wildlife until disturbed areas are adequately reclaimed. This disturbance would occur mainly in the pinyon-juniper, sagebrush, and mountain browse vegetation types. Based on present data, no significant impacts would occur to threatened, endangered or rare plants.

Wildlife -- This alternative would result in the short-term loss of wildlife habitat and population declines on approximately 36,000 acres. The most important loss would be a mule deer population decline or mule deer carrying capacity loss of approximately 2,000 animals. Water used for project development would impact the quality and quantity of aquatic environments and decrease available surface water for wildlife use. Increases in local human populations would provide major primary and secondary impacts to the wildlife resource.

Paleontological Resources -- Impacts upon paleontological resources are not expected except for unknown and undiscovered resources affected by the Multi Mineral Corporation's sodium mine development and surface disturbing activities.

Recreation -- Increased populations (30 to 75 percent for Meeker) in the region may increase hunting pressure throughout the Piceance Basin thus decreasing hunting quality. On the proposed tracts, hunting of mule deer, and cottontail would be displaced on and near the Multi Minerals Sodium Mine. No other recreation uses would be affected.

Socioeconomics -- Even without leasing, the communities of Rifle and Meeker would be experiencing rapid growth from the projects in the region that would already be causing "boom" conditions. The Town of Rangely would be receiving moderate growth impacts. Rifle would receive the most social impacts, associated with boom towns. The typical influx of new construction workers creates a short-

age of community facilities and service and an alienation with existing townspeople.

Rio Blanco and Garfield Counties would receive significant economic impacts from energy developments. Adverse effects include housing shortages, lack of "front-end" community services, capital development monies, new competition for existing work forces and local inflation. Benefits include increased employment opportunities and higher salaries. Other economic changes that may be considered beneficial by some and negative by others include the commercial/residential development of agricultural lands and land speculation.

Transportation -- An increase in haul truck traffic from the Multi Minerals sodium mine would create some road damage on State Highway 13/789 between Rifle and Rio Blanco, and along Piceance Creek Road (County Road 5). The additional 180 haul trucks would raise use to 56 percent of the capacity of the state highway, and 24 percent of the capacity of the county road. Resulting annual repair costs by 1988 would be $222,000 to the State, and $218,000 to Rio Blanco County.

C-11 Alternative

Tract Description

This alternative examines the possibility of leasing only Tract C-11. This tract lies about eight miles east of Tract C-a and one mile west of Piceance Creek. The tract contains 5,118.08 acres. The legal description is as follows:

T1S, R97W, 6th PM, Rio Blanco County, Colorado

Sec. 29: W1/2SW1/4

Sec. 30: All

Sec. 31: All

Sec. 32: W1/2W1/2

T2S, R97W, 6th PM, Rio Blanco County, Colorado

Sec. 5: W1/2W1/2

Sec. 6: All

Sec. 7: N1/2N1/2

Sec. 8: NW1/4NW1/4

T1S, R98W, 6th PM, Rio Blanco County, Colorado

Sec. 34: E1/2NE1/4

Sec. 35: All

Sec. 36: All

T2S, R98W, 6th PM, Rio Blanco County, Colorado

Sec. 1: All

Sec. 2: All

Sec. 3: Lots 5 and 6

Sec. 12: Lots 1 and 2

While irregularly shaped, this is a minable unit readily accessible from Piceance Creek Road via either Horse Draw (Sec. 29) or Ryan Gulch Road. This option provides excellent opportunities for plant and mine support facility siting, and for surface waste disposal into the head of Horse Draw or gulches tributary to Ryan Gulch. The irregularities along the west edge might complicate efficient mine layout appreciative of the NW-NE joint and fracture pattern. Leasing is currently complicated by the existing BLM/Bureau of Mines operating agreement that applies in whole or part to these sections. The existence of the Bureau of Mines shaft in Section 29 can be viewed as both a benefit or disadvantage to any future lessee. While it would provide any lessee with immediate access to the resource interval, the small shaft diameter (8 feet) limits its use to probably little more than initial resource sampling and possible secondary ventilation and emergency escape shaft for a commercial mine. A description of the mineral resources available on Tract C-11 is included in Chapter III, Geology.

Summary of Impacts

Leasing of Tract C-11 would result in the following impacts. A more specific discussion is contained in Chapter IV, Environmental Consequences.

Air Quality -- Production of either a 25,000 or 50,000 bbls/day operation would not significantly affect air quality. However its contributions of TSP, SO_2 and NO_x would add to existing emissions stated in the No Action Alternative and result in violations of the National Ambient Air Quality Standards and the Prevention of Significant Deterioration (PSD) Class II incremental standards in the Rifle and Book Cliffs areas earlier than the year 2003.

Geology -- Under existing technologies, a certain portion of the resource will be rendered unrecoverable. Estimated recovery of oil shale resources under the direct mining and surface retort methodology would result in a permanent loss of the following resources as unmined or unproduced intervals, mine pillars, plant pillars, and process inefficiencies. Future improvements in mining and retort-

ing efficiencies may significantly reduce these estimates of resource loss.

- 75 percent of the estimated 9.2 billion barrels of oil shale in place,
- 85 percent of the estimated 3.8 billion tons of nahcolite in place, and
- 87 percent of the estimated 0.92 billion tons of dawsonite in place.

Mine assisted in-situ recovery would result in a permanent loss of:

- 84 percent of the in place oil shale,
- 82.5 to 91.3 percent of the in place nahcolite, and
- 85.9 to 88.2 percent of the in place dawsonite.

With the true in-situ methodology a possible permanent loss of:

- 96 percent of the in place oil shale,
- 98 percent of the in place nahcolite, and
- 98 percent of the in place dawsonite

Resource recovery could be achieved using the following mining methods or combinations utilized in the following zones.

Saline Zone -- Direct, mine assisted in-situ or true in-situ mining may be utilized. Recovery should probably be highest by direct mining. Mine backfilling would enable greater resource recovery by allowing use of smaller pillars. Recovery by dissolution and surface recrystallization of saline minerals by true in-situ mining may be possible. Recovery utilizing true in-situ dissolution mining is presently unknown.

Mahogany Zone -- Direct mining with surface retorting or mine assisted in-situ processing may be used in this zone. Direct mining with backfilling should provide for the highest resource recovery.

Leached Zone -- Some method of true in-situ mining would be best suited to this zone due to the broken, brecciated rock and generally poor mining conditions. True in-situ would utilize the natural permeability of this zone.

Alluvial Valleys, Floodplains, and Agricultural Lands -- The water quantity and quality could be materially damaged or impacted (disturbing some or all of the 580 acres of the alluvial valley) in the Ryan Gulch, Horse Draw and ultimately the Piceance Creek alluvial valleys. Other impacts would be the result of spent shale and sodium mineral surface disposal into, and/or topsoil removal for top-dress of spent shale elsewhere as a result of the direct mining and surface retort, and the mine assisted in-situ methodologies. Impacts to the floodplains of Ryan Gulch and Horse Draw are dependent upon a detailed mine plan; avoidance is recommended to reduce impacts.

The agricultural impacts described for the No Action Alternative would occur under this alternative, also. However, an additional 910 to 1,150 acres of agricultural land would be permanently converted for urban expansion in nearby communities.

Soils -- The topsoil displacement and loss of soil productivity impacts described for the No Action Alternative would also occur under this alternative. These impacts would occur on an additional 1,200 to 3,200 acres depending on the development scenario selected where surface disturbance would occur. Soil impacts would be similar in type and quantity for direct mining and mine assisted in-situ development because of the reclamation difficulties in achieving adequate soil stabilization on spent shale piles. Soil impacts from true in-situ would be less than for the other two development techniques. Leasing Tract C-11 would be more damaging to the soil resource than leasing Tract C-18 due to the greater number of acres of shallow, more erosive sideslope soils, alluvial valleys, and the predominance of south facing slopes present on Tract C-11.

Hydrology-- Approximately 8,000 acre ft/yr of water will be needed for a 50,000 bbls/day operation. Eleven thousand acre ft/yr from mine dewatering will require surface disposal or reinjection. One-half of these figures would be necessary for a 25,000 bbls/day operation. According to modeling results reinjection will not be possible on-tract and will have to be located off-tract, however, actual field tests could change these results.

Mine dewatering could cause water level declines on and adjacent to the lease tract. Springs and public water reserves receiving their supply from the dewatering area could be impacted.

Recovery of the groundwater and surface water systems (according to modeling results) may take as long as three to ten years, respectively, after mine dewatering ceases. Due to modeling inefficiencies this period of recovery may be significantly longer or shorter. Upon abandonment, aquifer mixing may occur through shafts or subsurface retorts.

Leaching of toxic substances may occur in the spent subsurface retorts of the mine assisted in-situ and true in-situ methodologies. Leaching of spent shale backfill material may occur in the direct mining and suface retort and mine assisted in-situ methodologies. Movement of leachates may take as long as 100 to 200 years to reach Piceance and Yellow Creeks. Leasing of Tract C-11 will affect

Ryan Gulch and Piceance Creek rather than Yellow Creek due to the proximity of the tract to these drainages.

The White River could suffer a reduced flow of two percent for a 50,000 bbls/day operation and a one percent reduction for a 25,000 bbls/day operation. Salt loads to the White River could be reduced by as much as 3,000 tons per year.

A water augmentation plan will be required under state water law to replace lost sources of water due to mine dewatering. Also a monitoring program will have to be established to prevent degredation of state water quality.

Vegetation -- The vegetation impacts described for the No Action Alternative are applicable to this alternative. These impacts would occur on an additional 1,200 to 3,200 acres and result in an additional short-term loss of 125 to 240 AUMs or six to eleven percent of the AUM's present on the allotment depending on the development scenario selected. The initial quantity of vegetation disturbed from mine assisted in-situ, direct mining and true in-situ development would be 1,200, 1,400 and 3,200 acres, respectively. However, assessment of reclamation potential indicates vegetation would be impacted more severely from mine assisted in-situ and direct mining development than from true in-situ development due to difficulties in establishing and maintaining vegetation over the long-term on spent shale piles. Additionally, leasing Tract C-11 would be more damaging to vegetation over the long-term than leasing Tract C-18 due to reclamation potential of soils. Rangeland projects would be adversely impacted to a greater degree under this alternative than from the C-18 alternative due to additional surface disturbance on vegetation manipulations and less distance between a water well and the area to be dewatered.

Wildlife -- In addition to the wildlife impacts described for the No Action Alternative, the following impacts would occur. Destruction or alteration of habitat would remove forage and cover available for wildlife use on an additional 1,200 to 3,200 acres. The severity of this impact ranked from greatest to least impactive by development scenario is as follows: direct mining, mine assisted in-situ, true in-situ. This habitat loss would impact mule deer carrying capacity 41 percent more on Tract C-11 than for Tract C-18.

Human encroachment on-tract and secondary off-tract impacts would decrease habitat effectiveness for wildlife. These impacts would be 41 percent greater from leasing Tract C-11 than for leasing Tract C-18.

A significant increase in vehicle-related deer kills would occur. The number of deer killed would be 15 to 86 percent greater under the C-11 alternative than for the C-18 alternative depending on production level and stage of project operation.

Impacts to the aquatic resource in Piceance Creek and Yellow Creek should be insignificant if a water management plan is properly developed and implemented.

No significant impacts to threatened or endangered wildlife species would occur from leasing this tract. However, significant impacts may result from tract development to the Colorado River squawfish depending on the quantity and source of water required for mining.

Cultural Resources -- Impacts to cultural resources could occur if inadvertent destruction to previously undetected subsurface archaeological sites takes place during land disturbance associated with project development. Possible vandalism due to increased human activity would also be an unavoidable adverse impact.

Paleontological Resources -- Known fossil locations in the northeastern portion of the tract could be affected by earth disturbing or collecting activities. Impacts to important unknown or previously undiscovered paleontological resources could occur.

Recreation -- Hunting mule deer and cottontail would be displaced on or near the tract site. Hunter-camping would also be displaced on and near the tract. Hunter access would be somewhat limited in the immediate area of development.

Socioeconomics -- Under the low production rate (25,000 bbls/day) the town of Rangely would receive moderate social impacts, while Rifle and Meeker would receive severe impacts. Under the high production rate (50,000 bbls/day), Rangely would again receive moderate impacts, but Rifle and Meeker would sustain very severe effects. The towns of Silt, New Castle, Parachute, Battlement Mesa, Glenwood Springs, Carbondale and Grand Junction would not receive significant impacts.

Housing requirements under this alternative would increase 48 percent to 51 percent for the Town of Meeker, the most severely affected community. The next most affected town would be Rifle, with 35 percent to 43 percent increases in needs for housing.

Increases in crop sale losses would be 28 percent for Rio Blanco, 13 percent for Garfield and 10 percent for Mesa Counties.

Increased property and/or sales taxes would be $380,000 to $520,000 for Meeker and $720,000 to $970,000 for Rifle over projected revenues for 1988. Also, total employment for the three county

area would increase approximately 5 percent for the peak construction period of 1988.

Transportation -- This alternative would result in 220 trucks per day for the low production rate under the true in-situ scenario, or 440 trucks per day for a high production rate under the true in-situ scenario. The low and high production rate for direct or mine assisted methods would be 1,119 and 2,238 trucks per day for either road segment.

It becomes apparent that while there is a significant increase or difference in development scenarios, there is a dramatic difference between true in-situ and direct or mine assisted mining methods. This is because more products are recovered for direct mining and mine assisted in-situ than from true in-situ methods.

Traffic capacities would range from 61 to 100 percent for Highway 13/789 and from 26 to 70 percent for Piceance Creek Road (County Road 5). Increased costs would range from $270,000 to $2,760,000 for both the state and county roads.

Net Energy Analysis -- The mine assisted in-situ development scenario would be the most energy efficient recovery method, followed by direct mining with surface retorting. True in-situ would be the least efficient method.

Existing Rights -- Mining activities on Tract C-11 could affect two gas line rights-of-way, three public water reserves, 15 oil and gas leases, and the Bureau of Mines' research facility at Horse Draw.

Surface Reclamation and Solid Waste Disposal -- Reclamation of surface disturbances would be essentially the same for the direct mining and surface retort, and the mine assisted in-situ retorting methodologies (provided backfilling of spent shale is done under the direct mining methodology).

Surface disposal will require intensive reclamation due to the leachability and possible toxicity of spent shale and the extent of shallow soils and sparse vegetation on the predominantly southern aspect of this tract. Surface disturbance of the tract will be increased if topsoil is borrowed from other areas to top-dress spent shale waste piles.

Depending on location and design of waste disposal piles, spent shale will eventually become exposed to the surface environment due to natural forces. Exposure of spent shale will result in degredation of surface water quality and decreases in the established vegetative areas of the previously reclaimed areas.

True in-situ technology has the most surface disturbance and potential for soil loss of any other methodology, however, reclamation will not be as difficult due to the absence of spent shale waste piles.

Establishment of shrub and tree species to mature growth forms will be difficult and tenuous at best on spent shale piles due to the toxicity of spent shale and the shallow soils.

C-18 Alternative

Tract Description

This alternative examines the possibility of leasing only Tract C-18. This tract lies about six miles east of Tract C-a, immediately to the north of Tract C-11. The tract abuts the private lands along Yellow Creek to the northwest. The tract contains 5,118.14 acres. The legal description is as follows:

T1S, R98W, 6th PM, Rio Blanco County, Colorado

Sec. 13: All

Sec. 14: All

Sec. 15: E1/2, SE1/4NW1/4, SW1/4

Sec. 22: E1/2, E1/2W1/2

Sec. 23: All

Sec. 24: All

Sec. 25: All

Sec. 26: All

Sec. 27: E1/2

This tract is a logical mining unit. The area contains excellent siting opportunities for plant and mine support sites, surface waste disposal areas in the upper reaches of three northward-trending gulches tributary to Yellow Creek, and access from the Piceance Creek road along Ryan Gulch and Yellow Creek, thence up the gulch through Sections 15 and 22. A description of the mineral resources available on Tract C-18 is included in Chapter III, Geology.

Summary of Impacts

Leasing of Tract C-18 would result in the same impacts as described under C-11, with the following exceptions. For more details, see Chapter IV, Environmental Consequences.

Geology -- Estimated recovery of resources under the direct mining and surface retort methodology could result in a permanent loss of the following resources as unmined or unproduced inter-

vals, mine pillars, plant pillars, and process inefficiencies. Future improvements in mining and retoring efficiencies may significantly reduce these estimates of resource loss.

- 84 percent of the 10.2 billion barrels of oil shale in place,
- 85 percent of the 4.1 billion tons of nahcolite in place, and
- 89 percent of the 1 billion tons of dawsonite.

Mine assisted in-situ recovery could result in a permanent loss of:

- 89 percent of the in place oil shale,
- 90 percent of the in place nahcolite, and
- 92 percent of the in place dawsonite.

True in-situ recovery could result in a permanent loss of:

- 98 percent of the in place oil shale,
- 98 percent of the in place nahcolite, and
- 99 percent of the in place dawsonite.

Alluvial Valleys, Floodplains, and Agricultural Lands -- The water quality could be materially damaged or impacted in the Yellow Creek alluvial valley. Impacts would be caused by surface disposal resulting in leachates that could affect Yellow Creek.

Impacts to the floodplain of Yellow Creek would depend upon a detailed mine plan; avoidance is recommended to reduce impacts.

Soils -- These impacts would be the same as those described for C-11, except that less damages would occur because there are fewer shallow sideslope soils and more deep upland soils on C-18 that are more easily reclaimed.

Vegetation -- Approximately 0 to 15 fewer AUMs would be impacted over the short-term under this alternative than for the C-11 Alternative. However, over the long-term due to reclamation potential of soils, leasing Tract C-18 would be less damaging to vegetation than leasing Tract C-11. Rangeland projects would be impacted to a lesser degree under the C-18 Alternative than under the C-11 Alternative.

Wildlife -- The quantity of habitat destroyed or altered, the impact ranking of development scenarios, aquatic impacts, and impacts to threatened or endangered species would be the same as those wildlife impacts described for the C-11 Alternative. However, the following impacts would be quantitatively less under the C-18 Alternative than for the C-11 Alternative:

- a 41 percent reduction in mule deer carrying capacity from habitat loss,
- a 41 percent reduction of on-tract human encroachment and secondary off-tract impacts, and
- a 15 to 86 percent reduction in vehicle-related deer kills.

Cultural Resources -- Impacts to cultural resources would be the same as under the C-11 Alternative, except that more disturbance to subsurface sites could occur since the density of known sites on Tract C-18 is higher than that on Tract C-11.

Paleontological Resources -- Known fossil locations in the northern portion of the tract could be affected by earth disturbing or collecting activities. Impacts to unknown and previously undiscovered paleontological resources could occur.

Socioeconomics -- The same impacts would be felt as for C-11, except that housing requirements would be increased by 30 percent to 38 percent for Meeker and Rifle.

Increased property and/or sales taxes would be somewhat less than the C-11 Alternative because the sodium mine would be a separate tax entity under C-11 but not C-18. Increased taxes for Meeker would be $170,000 to $310,000 and $560,000 to $810,000 for Rifle. Total employment increases for the three county area would be about three percent for 1988; or two percent less than the C-11 Alternative.

Transportation -- This alternative would result in 40 trucks per day for a low production rate under the true in-situ scenario, and 260 per day for a high production rate. Using either direct or mine assisted methods, the figures would be 939 to 2,058 trucks per day for either road. The main difference between this alternative and C-11 would be the fact that if C-11 is selected, separate sodium production/trucking impacts would occur with true in-situ methods. If C-18 is chosen along with an in-situ method, the amount of minerals from other development would be reduced significantly.

Road capacities would range from 58 to 94 percent for the state highway and from 24 to 67 percent for the county road, depending on development scenarios and production rate. Repair costs would range from $50,000 per year to $2,300,000 per year with only a slight variation between Highway 13/789 and Piceance Creek Road due to some route variation from the sodium mine.

Existing Rights -- Mining activities on C-18 could affect two road rights-of-way, 11 oil and gas leases, and the existing sodium lease held by Wolf Ridge

Corporation. Prior to any lease sale of this tract, an assignment agreement must be negotiated for the sodium minerals held by the current lessee, so that multiple mineral extraction can occur.

Surface Reclamation and Solid Waste Disposal -- Reclamation of C-18 would include all the items listed for the C-11 Alternative, with the following differences:

The predominantly northern exposure and gentle slopes would be more conducive to reclamation. Spent shale waste disposal piles would stay covered with soil for a longer period of time on C-18, and topsoil is more readily available for this purpose.

Combined Alternative

This alternative examines the possibility of leasing both Tracts C-11 and C-18, or a total of 10,236.22 acres. The tract descriptions (including legal descriptions) are included for C-11 and C-18 in the alternative above.

Environmental impacts resulting from leasing both tracts are generally the cumulative total of the impacts described for C-11 and C-18, effectively doubling the impacts described for leasing either tract alone. Areas where this is extremely severe or where they are not a summation of impacts, are described below:

Air Quality -- Production of both tracts at 50,000 bbls/day (100,000 total) would violate the PSD Class I incremental standard of 5 micrograms/cubic meter for SO_2 at a level of 9.4 micrograms/cubic meter by the year 2003 in the Flat Tops Wilderness Area. Other impacts would be the same as those listed for Tract C-11.

Geology -- Impacts to geology would be the same as those described for Tract C-11 with the exception of the following:

Estimated recovery of resources under the direct mining and surface retort methodology will result in a permanent loss of;

- 80 percent of the estimated 19.4 billion barrels of oil shale in place.
- 85.4 percent of the estimated 6.4 billion tons of nahcolite in place,
- 87 percent of the estimated 1.6 billion tons of dawsonite in palce.

Mine assisted in-situ recovery could result in a permanent loss of;

- 86.6 percent of the in place oil shale,
- 90.4 percent of the in place nahcolite; and
- 91 percent of the in place dawsonite.

True in-situ recovery could result in a permanent loss of;

- 94.7 percent of the in place oil shale;
- 97 percent of the in place nahcolite; and
- 95 percent of the in place dawsonite.

Hydrology -- Impacts to hydrology systems from leasing both tracts would be as described under the C-11 and C-18 Alternatives, with the following exceptions.

Approximately 16,000 acre ft/yr of water would be required for development and 22,000 acre ft/yr would be required for surface or subsurface disposal from mine dewatering of a 100,000 bbls/day operation. A 50,000 bbls/day operation would involve approximately one-half less water than the 100,000 bbls/day operation.

Flow of the White River would be reduced by four percent at 100,000 bbls/day and two percent at 50,000 bbls/day. Total salt loads contributed to the White River at 100,000 bbls/day production would be reduced by approximtely 6,130 tons/year. As a result of mine dewatering, Yellow Creek will become dry over 50 percent of the year (during summer months). Also, Piceance Creek would experience periods of no flow in the summer.

Recreation -- Hunting mule deer and cottontail would be displaced on and near the proposed tract sites.

Access would be somewhat limited in the immediate area of development for hunters. Hunting pressure would increase with population increase. Hunting opportunities may be denied to some hunters if the state decides to implement a permit system due to increased hunting pressure from the peak construction period.

Socioeconomics -- If both tracts are developed, regardless of development scenario, the Town of Rangely would receive severe social impacts and the towns of Rifle and Meeker would have impacts classified as very severe. Additionally, the towns of Silt, New Castle, Glenwood Springs and Carbondale would feel the effect for the Combined Alternative.

Housing requirements would be increased by 58 percent to 63 percent for Meeker and 50 percent to 58 percent for Rifle.

Increases in Crop Sales Losses for the Combined Alternative would be 29 percent for Rio Blanco County, 23 percent for Garfield County and 21 percent for Mesa County.

Increased property and/or sales taxes would be $560,000 to $840,000 for Meeker and $1,290,000 to $1,790,000 for Rifle, over projected revenues. Total employment for the three county area would increase approximately 8 percent for the peak construction period.

Transportation -- This alternative would result in 260 to 700 trucks per day for a low to high production rate comparison, using true in-situ methods. Using direct or mine assisted methods would result in 2,058 to 4,296 haul trucks per day.

Traffic capacities would range from 66 to 137 percent for the state highway and from 29 to 111 percent for the county road. Repair costs would range from $1,500,000 to $3,000,000 annually.

The most significant impacts to transportation would occur from either direct or mine assisted in-situ mining methods in steady-state production (1993) low or high development scenario of the Combined Alternative; and the high scenario for all three development alternatives.

Noise -- Significant noise increases would be produced by increased truck traffic along State Highway 13/789, between Rifle and Rio Blanco, and on County Road 5 between Rio Blanco and the tracts, for the high (100,000 bbls/day) production rate, using either the direct or mine assisted in-situ methods of mining. Noise levels would be increased from 69 to 78 db, at 50 feet from the highways, almost doubling the perceived noise level.

Development Scenarios

Regardless of which tract(s) is leased, the geotechnical setting is essentially the same permitting the use of essentially similar methods to recover shale oil and associated saline minerals. Possible development scenarios can be generally categorized as methods involving direct mining and surface retorting, mine assisted in-situ processing, and true in-situ. Tract development would probably begin in the Saline Zone with subsequent production from the upper zone shales, principally the Mahogany Zone, as the lower zone resources being to play out, achieving a sustained production of 25,000 to 50,000 bbls/day of shale oil for each tract after 1993. For purposes of this analysis, mine life is assumed to be 30 years, beginning with lease sale in 1983. Actual mining will probably occur for a longer period up to 100 years or more, however, predictions of impacts beyond 30 years would be speculative at best.

Direct Mining And Surface Retorting

Direct mining would require sinking of two or more large diameter shafts (15-30 feet) approximately 3,000 feet deep with one or more supplemental small diameter shafts for secondary ventilation utility lines, and emergency escape. From these shafts, up to several mine levels would be advanced across the tract probably along either a zone of bedded nahcolite or high grade (> 30 gallon/ton) oil shale. As these mine levels are advanced, one or more of several possible deep mining methods could be utilized to recover the bulk of the resource, including room-and-pillar, chamber-and-pillar, sublevel stoping, and crater retreat.

Room-and-pillar mining is the only method proven in oil shale to date at test mines along the southern edge of the Piceance Basin. This method involves mining out rooms of oil shale, leaving large blocks of resource in place to support the overburden. Generally, up to 60 percent of the resource across the mine interval can be recovered and moved by large trucks or conveyor systems to the production shaft for hoisting to the surface. However, over the entire breadth and thickness of the resource (for both C-11 and C-18) rock strength and efficiencies of currently available technology would probably limit overall recovery to not exceed 30 percent.

Chamber-and-pillar involves excavation of large rectangular rooms separated by long narrow pillars. Blast holes are drilled in a fan shaped pattern to the side and above the mine level, charged, and blasted to create a rubble filled chamber. Large loading machines, trucks, and conveyors are used to move the rubble to the production shaft for hoisting to the surface.

Sublevel stoping and crater retreat are methods of mining out an interval of oil shale between upper and lower mine levels that may be up to several hundred feet apart. The intervening oil shale is drilled and explosively rubblized. For sublevel stoping, large rectangular cavities are created, by drawing the rubble out through draw points feeding a haulage way mined below the lower blast hole drilling level. Cratering results in blasting off thick sections of oil shale between the mine levels and mucking out the rubble from the lower development level. Stoping has an overall extraction rate of 50 to 60 percent, while cratering can recover nearly all the shale between the mine levels.

For any of these methods to achieve maximum recovery and to stabilize the mine level so that overlying resources can be safely extracted with minimal impact on upper zone aquifers, it will be

necessary to backfill mined out areas. Surface retorted oil shale can be mechanically or hydraulically back stowed. Removal of nahcolite will create sufficient excess void space so that virtually all of the surface processed shale can be backfilled at full production.

Direct mining will yield both bulk nahcolite during initial mining in the saline zone and combined oil shale and saline minerals during room and stope development. Bulk nahcolite will be further crushed on the surface and transported off-tract by truck. Remaining shale will be further crushed and nahcolite separated by optical/mechanical classification. The remaining shale can then be processed by one or more of surface retorting methods. Either unit can be directly heated by burning residual carbon on the shale fragments that form as the kerogen is broken down into oily gases and vapors; or indirectly heated by burning the carbon and/or process off-gas in external furnaces with the heat carried back to the retort chamber by a gaseous or solid working medium. Once retorted, the shale can be leached with a mild caustic water solution to dissolve out the alumina contained in the finely disseminated dawsonite. The now spent shale can be slurried or mechanically conveyed back to mined out areas to stabilize mine workings and minimize stratigraphic subsidence.

Estimated surface disturbance for mine shaft sites, surface facilities, and the mine support area is 200 acres. An additional 200 acres would be disturbed to construct the surface retort facilities. These disturbances would persist throughout the life of the mine. Approximately 1,000 acres would be required for surface waste disposal. However, only portions of this total acreage (approximately 200 acres) would ever be disturbed at one time since rehabilitation efforts would be implemented as soon as feasible to minimize erosion and particulate emission. Surface facilities consist of permanent shafts encompassed by large cement head frames. A large retort system would be needed for processing extracted materials. Warehouses, offices, and lay down yards provide working area and equipment storage sites. Additional structures would be needed for ventilation fans, utility systems, and water treatment plants.

Mine Assisted In-Situ

Mine assisted in-situ could proceed on two principal schemes. The method currently being field tested by industry involves driving mine levels above and below the interval of shale to be retorted. These levels would probably be mined along either nahcolite rich zones or very rich oil shale. Then enough in place material equal to 20 to 40 percent of the volume of the shale rock between mine levels is mined out. Mined material would be hoisted to the surface for nahcolite separation and shipment, and surface oil shale retorting and alumina recovery. The intervening oil shale would then be drilled and explosively fragmented into large rubble filled chambers up to an acre in area. These rubble filled chambers are then heated directly or indirectly at the top with special burners and supplied with air and steam to sustain and control heating to retort out the kerogen. Pyrolysis heat is drawn downward by differential ventilation pressure retorting the underlying oil shale. Oily gases and vapors tend to condense near the bottom of each chamber and are drawn to the surface for further separation through sealed mine shafts. In the Saline Zone, the rubble filled chambers could first be leached with water to dissolve out the nahcolite, then retorted. These burned out retort chambers could then be leached with a mild caustic solution to recover alumina.

A variation of this general scheme is to draw all the oil shales and nahcolite out of the rubble chambers to create large stopes, separate the nahcolite (to ship offsite) and crush the oil shale to uniform coarse size. The crushed shale is put back into the stope and retorted and leached as described above to recover oil, gas, and alumina.

Total surface disturbance for this scheme is less than required for Direct Mining and Surface Retorting due to smaller acreage requirements necessary for surface retort facilities and process waste disposal. Again, an estimated 200 acres would be required for mine shaft sites, surface facilities, a mine support area, and the surface retort facility. Less than 1,000 acres would be required for surface waste disposal piles.

Surface facilities for this technique would essentially be the same as required for Direct Mining and Surface Retorting with the exception of a smaller retort plant.

True In-Situ

True in-situ processing is carried out by drilling closely spaced boreholes from the surface through the interval to be developed. Communication is then established between well points by hydraulic or explosive fracturing or by leaching away soluble minerals, such as nahcolite. Once communication is established, remaining nahcolite is dissolved by circulated water. The pregnant liquor is drawn to the surface through selected well points, salts are precipitated and marketed as caustics soda. The re-

maining oil shale is then retorted in-place circulating superheated water or steam. The oily emulsion is pumped to the surface for oil water separation.

Resulting surface disturbance is variable for this technique based on topography. Approximately 200 acres would be permanently disturbed at the plant site and product storage areas. Minimal acreage would be required for surface waste disposal. However, a large percentage of the tract surface (3,000 acres) would eventually be temporarily disturbed during land leveling operations for borehole drilling activities.

Surface facilities would be centralized around a stationary separation facility or a "semi-mobile" separation facility. These facilities would house oil and water separators, steam generators, and product handling systems. A traveling network of drill rigs would be required to drill boreholes and initiate underground extraction activities. Temporary surface pipelines would connect and transport products from the boreholes to the separator facility.

Upper Zone Shale Recovery

Once the Saline Zone shales have been processed, it would be possible to recover oil and gas from the upper zone shales using either a direct mining method or mine assisted in-situ. The method selected would depend on zone thickness and ground conditions.

Resource Requirements

For each of the development scenarios described above, associated resource needs have been identified that would apply to the rate of production, regardless of development technique. These resource requirements are described below.

Employment

Based on available employment projections for existing oil shale operations, a rough correlation between daily oil production and required construction and operating work force can be made. For purposes of this analysis, it is assumed that steady state production employment will be achieved ten years after lease sale (1993), with a range of production from 25,000 bbls/day to 50,000 bbls/day for each tract by that year. Peak construction employment would occur approximately five years after lease sale (1988).

Given these assumptions, the following employment estimates can be assumed for each tract:

Production (bbls/day)	Work Force: Peak Construction 1988	Work Force: Peak Operation 1993
25,000	1,700	1,125
50,000	2,200	1,400

If two tracts are leased, it is assumed that these numbers would roughly double, with the recognition that such an assumption may be a "worst case", since no two projects will be at exactly the same point in their development at the same time, and some employees with specific skills may be utilized by more than one project.

For both tracts, it is assumed that the work force would live in the following locations: Rio Blanco County 40 percent (Meeker 30 percent, Rangely 7 percent, elsewhere 3 percent), and Garfield County 60 percent (Rifle 50 percent, Silt 3 percent, Parachute 2 percent, elsewhere 5 percent).

Product Transportation

At peak production it is anticipated that the following products will need to be transported out of each tract annually. The production estimates apply for both the direct mining and mine assisted in-situ scenarios. For the true in-situ scenario, only shale oil and caustic soda would be produced in the quantities shown below.

Product	Production Rate: 25,000 bbls/day	Production Rate: 50,000 bbls/day
Shale Oil	8,048,750 bbls	16,097,500 bbls
Soda Ash	831,250 tons	1,662,500 tons
Alumina	263,750 tons	527,500 tons
Caustic Soda	1,000,000 tons	2,000,000 tons
Sodium Bicarbonate	62,500 tons	125,000 tons
Carbon Dioxide	277,500 tons	555,000 tons
Nahcolite I	2,500,000 tons	5,000,000 tons
Ammonia (liquid)	49,755 tons	98,550 tons
Sulfur	27,375 tons	54,750 tons
Coke	91,250 tons	182,500 tons

Transporting these products to markets (typically hundreds of miles distant) or to existing common carrier dump points or rail sidings on existing roads will be a significant activity. During early scale-up phases of production, it will probably be feasible to transport oil products by truck. Shale oil could probably be taken to Rangley and pipelined from there, or to Rifle for shipment by rail while dry products and ammonia would probably be trucked to Rifle for rail shipment.

Transportation costs tend to dictate that most products be reduced to as low a volume and as high a value as practicable prior to transporting. Thus, most shale oil probably will be treated to the level of refinery feedstock prior to transporting. Pipelines appear to be the most practical method of moving shale oil and possibly ammonia. Sulfur, coke, and sodium and alumina minerals probably will be shipped by rail.

Water Use

Water requirements are somewhat process-dependent, and many estimates to date for oil shale

extraction are in the range of one to four barrels of water per barrel of shale oil produced. Thus the range in requirements for a 50,000 bbl/day plant would be from about 6.4 acre ft/day to 25.8 acre ft/day, or from about 2,300 to 9,300 acre ft/yr. Estimates for a 25,000 bbl/day plant would be approximately half this figure. Water requirements for handling and reclamation of processed shale make up a significant portion of the total water needed; given the range in possibilities of mining, backfilling, surface disposal of shale, and retorting, this portion of the water requirements could range from about 1/4 to more than 1/2 the total.

Other water uses include dust control, stack-gas scrubbing, revegetation, process steam and water, upgrading, mining, and power generation. If mines are "wet", a significant amount of water will be removed as moist air by the mine ventilation system. Water requirements for sodium-aluminum extraction are not well known at this time, but would utilize a high percentage of recirculation and probably would be within the range of above estimates.

In addition, municipal water use by the increased population will amount to some 100 gallons per day per person or about 11,000 acre ft/yr. per 10,000 population.

Alternatives Considered But Eliminated

A number of other alternatives have been suggested, but were eliminated from detailed study. A brief description of these alternatives is presented below with the reasons for their elimination from further consideration. No other alternatives were presented that would have fewer apparent impacts, or that would better meet the Department of Interior's goals for the prototype program.

Offering More Than Two Leases

The decision made by the Assistant Secretary of the Interior for Land and Water Resources in November 1981 stated that BLM's oil shale program should include provisions for offering one or two tracts by early 1983 as part of the prototype leasing program. If feasible, these lease offerings should be designed specifically to provide opportunity for the cuncurrent development of oil shale and associated minerals in the Saline Zone, as well as other appropriate technologies. It is believed that these objectives can be met by offering one or two tracts under the prototype program. The need for more than two tracts has not been demonstrated.

Offer Tracts Larger Than 5,120 Acres

New legislation is pending before the U.S. Congress to increase tract size, provide for off-tract disposal of spent shale, and allow for the holding of more than one lease by any one company or individual. Nevertheless, it has been assumed for purposes of this document that prototype leasing is subject to existing laws and regulations. The Mineral Leasing Act of 1920 limits tract size to 5,120 acres, the maximum considered in this Environmental Impact Statement.

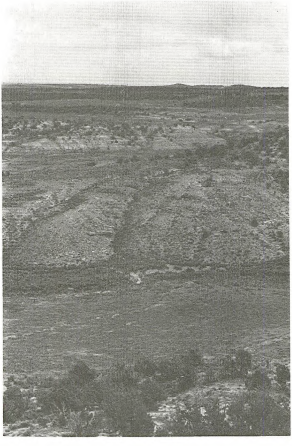
Analyze Areas Outside The Six Areas Offered

Five of the six areas offered for expressions of leasing interest were examined in the *1973 Prototype EIS*, and were subsequently identified in the White River Management Framework Plan as those areas where additional oil shale leasing should be offered first. The sixth area offered is a tract comprised of the two existing sodium leases in the basin. Since multiple resource recovery technology is one of the goals of this round of the prototype program, it was felt that offering any existing sodium leases for concurrent oil shale development was appropriate and within the discretion of the Secretary of Interior. In fact, three of the four expressions of leasing interest were for this sodium lease tract. It is felt that these lands were sufficient to meet the needs of the prototype oil shale program. While some interest was mentioned in areas outside the six tracts offered (including nearby Sodium Preference Right Lease Application tracts), the development technologies proposed can be used on the two tracts being analyzed. There would be no environmental advantage to offering tracts other than the two analyzed here.

Analyze Tract II (a redelineation of tract C-6 from the 1973 Environmental Impact Statement)

This tract was identified as being of secondary interest (or less desirable but still of interest) since the technologies recommended for the tract could be better employed on tract C-11. It was determined that since C-11 was more desirable, and no new or different technologies were proposed for Tract II than for C-11, there was no need to offer both tracts for lease.

Aerial view looking north across the northern portion of tract C-18 towards the lower reaches of Yellow Creek. June 10, 1982



View looking east across Yellow Creek to tract C-18.

Offer Only One Lease For Sale, But Open Two Tracts For Bidding

The idea behind this proposal would be to seek the highest bid for a single lease. Such an option could be considered by the Secretary of Interior in making his decision. This has not been addressed as a separate alternative since the result would be leasing either C-11 or C-18 and the impact of both these alternatives are already being examined.

Analyzing The 1,320 Acres Of The Sodium Lease Tract West Of Yellow Creek

An expression of interest was received from the Nielson Resources Corporation for 1,320 acres of the sodium lease tract west of Yellow Creek for a multiple resource recovery process concurrent with oil shale development. Nielson is part owner of the Rock School Corporation which holds the sodium lease for this 1,320 acres. This tract has been eliminated from further consideration for two principal reasons: (1) it is only one-fourth the size of the maximum allowable lease acreage and could not be judged on the same competitive basis as the two larger tracts; and (2) it is not a "logically shaped" mining unit and is further complicated by a satellite parcel of 120 acres separated by private land along Yellow Creek with divided estate (surface - state of Colorado Division of Wildlife, mineral - Bell and Cross Cattle Company). However, it could potentially be added to adjoining lands to create a larger tract for lease under the proposed permanent oil shale leasing program sometime in the future.

Delay or Phase Prototype Lease Sales Beyond The Proposed March 1983 Date

Currently, it is perceived that the only reason to consider such an alternative would be to wait for new technology to fully develop prior to leasing. However, it is felt that the development technologies proposed here are sufficiently evolved that such an alternative need not be considered. It is possible that there may be other reasons for delaying or phasing the lease sale. It is within the descretion of the decision-maker to require such a delay and the Secretary may make this decision prior to announcing a lease sale.

View looking northeast down Yellow Creek, (north of tract C-18).

CHAPTER III

AFFECTED ENVIRONMENT

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AFFECTED ENVIRONMENT

AIR QUALITY

The existing air quality of the Piceance Basin is typical of undeveloped regions in the western United States; ambient pollutant levels are usually near or below the measurable limits. Notable exceptions in this region include high, short-term concentrations of total suspended particulates (TSP) (related to local winds), ozone (O_3), non-methane hydrocarbons (NMHC) and carbon monoxide (CO), especially in nearby towns. Locations vulnerable to decreasing air quality from extensive energy-related resource development include the immediate operation areas (coal mines, ~~shale oil~~ retorts, etc.), local population centers with their induced impacts, and distant areas which can be affected through long-range transport of pollutants.

National and state ambient air quality standards limit the total amounts of specific pollutants (CO, lead, nitrogen dioxide (NO_2), NMHC, O_3, sulfur dioxide (SO_2), and TSP). These standards were established to protect public health (primary standards) and public welfare (secondary standards). Areas which consistently violate minimum standards because of man-caused activities are classified as Non-attainment Areas, and must implement a plan to reduce ambient levels below the maximum pollution standards (Table III-1). To protect areas not classified as Non-attainment, Congress established a system for the Prevention of Significant Deterioration (PSD) through the Clean Air Act Amendments of 1977.

Areas were classified by the additional amounts of TSP and SO_2 degradation which would be allowed. Class I areas, predominately National Parks and certain Wilderness Areas, have the greatest limitations; virtually any degradation would be significant. Areas where moderate, controlled growth can take place were designated as Class II. Class III areas are those areas which allow the greatest degree of impacts. Most of the study region is Class II - Grand Junction is a Non-attainment Area for TSP.

Class I areas closest to, and downwind from the proposed lease sites are the Maroon Bells-Snowmass, Flat Tops, and Mount Zirkel Wilderness Areas. Although they have Class II PSD status, other areas of special concern include Dinosaur and Colorado National Monuments and the Raggeds Wilderness Study Area. These areas are shown in Figure III-1. Arches and Canyonlands National Parks are also Class I areas, but their geographic and meteorologic relationships to the proposed lease tracts make them less susceptible to air quality degradation.

Background concentrations of CO, lead, NO_2, NMHC, O_3, SO_2 and TSP measured in the region are presented in Tables III-2 and III-3. Higher TSP levels would be expected near towns due to local combustion sources and unpaved roads, but the significant regional TSP concentrations are probably due to fugitive dust. Since fugitive dust particulates are larger than those produced in combustion processes, they present a minimal inhalation health threat. The Environmental Protection Agency may alter the existing TSP regulations to reflect this difference by setting standards for particulates less than 15 microns in diameter, commonly called thoracic particulates and abbreviated T_{15}.

Ozone levels in the Rocky Mountain west are relatively high (approximately 70 micrograms per cubic meter), and may be a result of long range transport from urban areas, subsidence of stratospheric ozone, or due to photochemical reactions with natural hydrocarbons. Occasional peak concentrations of CO and SO_2 may be caused by combustion equipment near monitors.

Class I PSD regulations also address the potential for impacts to Air Quality Related Values (AQRV). These AQRV's include visibility, odors, and impacts to flora, fauna, soils, water, geologic and cultural structures. A possible source of impact to AQRV's is acid deposition. Tables III-4 and III-5 summarize the existing levels of visibility and acid deposition of the study region.

Visibility impacts can occur from atmospheric increases in small, light-scattering particles or increases in light absorbing gases (typically NO_2). Mechanisms of acid precipitation formation are currently under study. Preliminary results have correlated ambient sulfuric and nitric acids with combustion by-products (sulfates and nitrates).

CLIMATE

Piceance Basin is located in a semi-arid, continental climate regime, characterized by dry air, sunny days, clear nights, little precipitation, extreme evaporation, and large diurnal temperature changes. Because of the surrounding mountains, low pressure storm systems tend to pass around

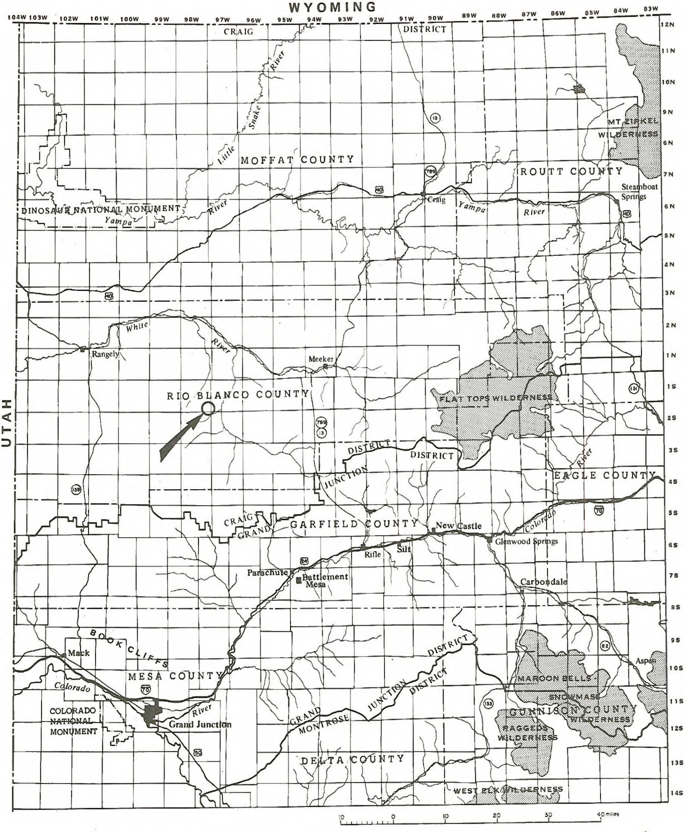
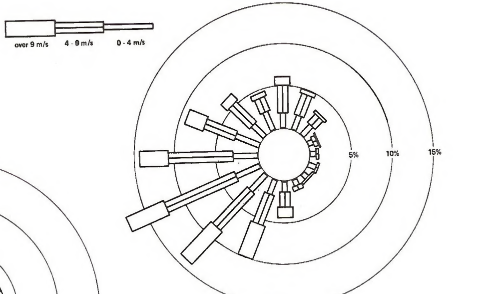
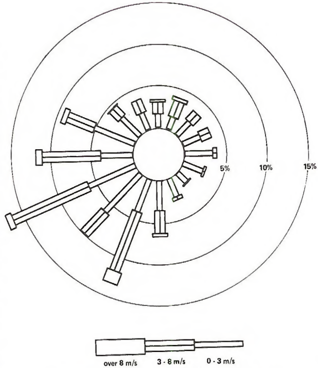


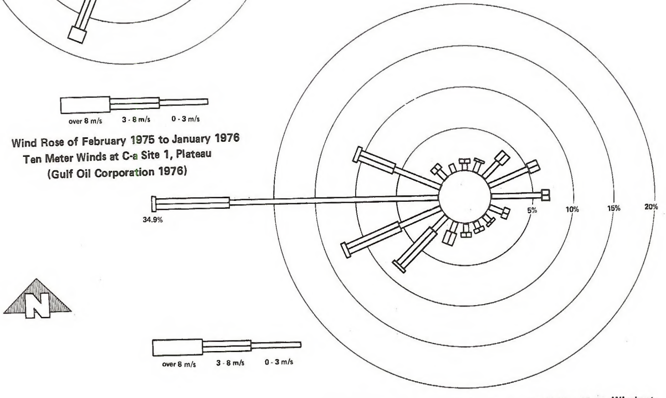
Figure III-1 Northwest Colorado Showing Approximate Location of Proposed Lease Tracts (arrow), Wilderness Areas, National Monuments in the Region, and Communities That May be Affected



Wind Rose of Annual 700 millibar (mb) Winds at Grand Junction, Colorado (Engineering Science 1974)



Wind Rose of February 1975 to January 1976 Ten Meter Winds at C-a Site 1, Plateau (Gulf Oil Corporation 1976)



Wind Rose of February 1975 to January 1976 Ten Meter Winds at C-a Site 3, Valley (Gulf Oil Corporation 1976)

Figure III-2

TABLE III-1
COLORADO AND FEDERAL AIR QUALITY STANDARDS

Pollutant	Averaging Time a/	Standards (Micrograms Per Cubic Meter)				
		Ambient b/		PSD Increments c/		
		Primary	Secondary	Class I	Class II	Class III
Carbon monoxide	8-hour	10,000	--	--	--	--
	1-hour	40,000	--	--	--	--
Lead	Quarterly	1.5	--	--	--	--
Nitrogen Dioxide	Annually	100	--	--	--	--
Non-Methane Hydrocarbons d/	3-hour (0600-0900)	160	--	--	--	--
Ozone	1-hour	240	--	--	--	--
Sulfur Dioxide	Annual	80	--	2	20	40
	24-hour	365	--	5	91	182
	3-hour	--	1,300	25	512	700
Total Suspended Particulates	Annual	75	60	5	19	37
	24-hour	260	150	10	37	75

a/ Short term standards (those other than Annual and Quarterly) are not to be exceeded more than once each year.

b/ Ambient standards are the absolute maximum levels allowed to protect either public health (primary) or welfare (secondary).

c/ Prevention of Significant Deterioration standards are the maximum incremental increase levels allowed above the baseline amounts of pollutants in regions of clean air.

d/ The Non-Methane Hydrocarbon standard was established as a guide in evaluating attainment of the ozone standard.

TABLE III-2

SELECTED AMBIENT GASEOUS POLLUTANT CONCENTRATION DATA (MICROGRAMS PER CUBIC METER)

Station	Period	Carbon Monoxide Avg. Time	Carbon Monoxide Ann. Mean	Carbon Monoxide 1st Max.	Carbon Monoxide 2nd Max.	Nitrogen Dioxide Ann. Mean	Nitrogen Dioxide Max.	Non-Methane Hydrocarbons Ann. Mean	Non-Methane Hydrocarbons 1st 3 hr Max.	Non-Methane Hydrocarbons 2nd 3 hr Max.	Ozone Ann. Mean	Ozone 1st 1 hr Max.	Ozone 2nd 1 hr Max.	Sulfur Dioxide Avg. Time	Sulfur Dioxide Ann. Mean	Sulfur Dioxide 1st Max.	Sulfur Dioxide 2nd Max.
Cathedral Bluffs a/																	
#020	1980	1	65	--	--	0.4	--	--	--	--	26	--	--	1	0.3	--	--
	1979	1	217	2,300	--	0.5	88	--	--	--	52	192	--	1	0.6	13	--
	1974-80	1	406	--	--	1.4	--	--	--	--	28	--	--	1	0.3	--	--
#023	1980	1	88	--	--	0.5	--	--	--	--	38	--	--	1	0.4	--	--
	1979	1	218	3,600	--	1.6	38	--	--	--	77	246	--	1	0.3	49	--
	1974-80	1	455	--	--	0.7	--	--	--	--	37	--	--	1	0.3	--	--
Chevron Tract b/																	
#E	10/80-9/81	1	115	5,405	--	3.8	66				69	149	--	1	2.6	21	--
Grand Junction, CO c/																	
	1980	1	--	16,100	13,225												
		8	--	7,015	7,015												
	1979	1	--	8,050	8,050												
		8	--	5,060	4,370												
Naval Oil Shale Reserve d/																	
	6/81-9/81										--	265	--	3	--	118	--
														24	--	69	--
	6/80-9/80										--	206	--	3	--	44	--
														24	--	13	--
Rio Blanco Tract e/																	
#1	12/79-11/80	1	575	1,035	--						98	157	--	1	5.2	58	--
	12/78-11/79	1	575	1,725	--						98	157	--	1	26	26	--
	12/77-11/78	1	575	575	--						118	176	--	1	26	79	--
#3	12/79-11/80	1	575	575	--						78	137	--	1	7.9	34	--
	12/78-11/79	1	--	--	--						78	157	--	1	26	236	--
	12/77-11/78	1	--	--	--						78	137	--	1	26	288	--

Note: Underlined values indicate violation of Ambient Air Quality Standards.

a/ Source: Cathedral Bluffs Shale Oil Company, 1981 and 1980.
b/ Source: Environmental Research & Technology, Inc, 1982.
c/ Source: Colorado Department of Health, 1981
d/ Source: TRW Energy Engineering Division, 1981.
e/ Source: Gulf Oil Corporation, 1981.

TABLE III-3
SELECTED PARTICULATE CONCENTRATION ANO COMPOSITION DATA (MICROGRAMS PER CUBIC METER)

Station	Period	TSP # Obs	TSP Ann. Geo. Mean	TSP 1st 24 hr Max.	TSP 2nd 24 hr Max.	T_{15} # Obs	T_{15} Ann. Geo. Meen	T_{15} Max.	Sulfate # Obs	Sulfate Ann. Arth. Mean	Sulfate 24 hr Max.	Nitrete # Obs	Nitrete Ann. Arth. Meen	Nitrete 24 hr Max.	Leed # 1/4	Leed Ann. Arth. Mean	Leed 1/4 Max.
Cathedral Bluffs e/																	
Site 020	1980	--	10	--	--												
	1979	--	16	63	--												
	1974-1980	--	12	--	--												
Site 023	1980	--	11	--	--												
	1979	--	16	81	--												
	1974-1980	--	12	--	--												
Chevron b/																	
Site A	10/80-9/81	--	11	227	224	--	4	--									
Site E	10/80-9/81	--	21	--	--												
Creig, Courthouse																	
	1980 c/d/e/	71	86	382	238				69	5.9	11.2	69	1.7	5.9			
	1979	41	93	206	170				24	3.5	5.6	24	1.1	1.6			
	1978	64	104	332	283												
Glenwood Springs, Courthouse c/d/																	
	1980	88	68	203	199												
	1979	85	57	188	173												
	1978	62	58	165	161												
Grand Junction, Rood St. c/l/																	
	1980	72	78	--	144	65	57	194	72	4.8	9.8	72	2.1	8.4	4	.75	1.0
	1979	83	82	183	176				64	4.4	12.6	64	3.8	30.7	4	1.0	1.5
	1978	77	75	148	142										4	.95	1.5
Grand Valley, High School c/e/																	
	1978	51	55	213	208												
	1977	35	(52)	334	217												
	1976	78	71	361	342												
Meeker, Courthouse																	
	1980 c/d/f/	70	66	212	171												
	1979	--	--	--	--												
	1978	42	55	138	130												
Naval Oil Shale Reserve g/																	
	6/81-9/81	14	(24)	37	--	14	14	29							--	.01	--
	6/80-9/80	--	--	30	--										--	.01	--
Rangely, Water c/d/ Treatment Plant e/																	
	1980	15	(70)	273	162												
	1979	22	(130)	342	324												
	1978	57	57	285	187												
Rifle, Third Ave c/																	
	1980 d/e/l/	69	156	510	479										2	--	0.5
	1979	83	128	694	660				66	3.6	12.2	66	1.8	10.6	4	.72	1.2
	1978	77	127	494	403										4	.68	1.1
Rio Blanco Tract h/																	
Site 1	12/79-11/80	--	13	61	--												
	12/78-11/79	--	11	303	--												
	12/77-11/78	--	14	59	--												
	2/75-1/77	--	9	211	--												
Site 3	12/79-11/80	--	18	96	--												
	12/78-11/79	--	21	192	--												
	12/77-11/78	--	26	160	--												
	2/75-1/77	--	15	281	--												
Rio Blanco e/																	
	1975	--	13	111	--												
	1973	--	14	144	--												
Steamboat Springs, Sixth St. c/l/																	
	1980	68	134	--	433				64	6.3	16.4	64	2.0	7.6	4	.38	0.5
	1979	62	118	518	450				51	4.0	10.9	51	1.9	6.7	3	--	1.3
	1978	69	152	982	902										4	.80	1.2
Superior Tract i/																	
	12/76-11/77	--	40	647	--											.3 j/	
Colorado Nat'l Monument k/																	
	1980	78	16	42	37												
	1979	86	15	67	62												
	1978	54	15	39	33												

Note: Underlined values indicate violation of Ambient Air Quality Standards, parentheses indicate insufficient data to determine reliable average.

a/ Cathedral Blufffs Shale Oil Company, 1981 and 1980
b/ Environmental Research & Technology, Inc., 1982
c/ Colorado Department of Health, 1981.
d/ Systems Applications Inc, 1982.
e/ Woodward-Clyde Consultants, 1981.
f/ Engineering-Science, Inc, 1974.
g/ TRW Energy Engineering Division, 1981.
h/ Gulf Oil Corporation, 1981.
i/ Bureau of Land Management, 1979.
j/ Concentration based on single sample.
k/ Lundy, 1982.
l/ Hague, 1982. T_{15} values are 1981 measurement; mean is arithmetic average.

TABLE III-4
SELECTED VISUAL RANGE DATA (Km)

Station	C-a/C-b a/ Photographic	Chevron b/ Nephelometer	Chevron b/ Radiometer	Colorado N.M Radiometer c/	Dinosaur N.M. Radiometer c/	Craig, CO c/ Radiometer
Spring 1975-76	-/111/-					
Fall 1975-76	-/147/-					
Spring 1978	-/127/-					
Fall 1978	-/129/-					
Spring 1979	-/124/-					
Summer 1979					146/179/242	
Fall 1979	-/135/-				153/192/274	
Winter 1980					d/	
Spring 1980	-/126/-				d/	93/142/216
Summer 1980				130/176/238	95/150/238	104/136/179
Fall 1980	-/150/-			145/197/267	146/203/283	96/144/217
Winter 1981		-/344/-	-/180/-	145/215/317	d/	113/170/258
Spring 1981	-/135/-	-/200/-	-/210/-	d/	d/	107/166/257
Summer 1981		-/250/-	-/170/-	120/166/229	95/135/192	94/140/209
Fall 1981	-/140/-	-/200/-	-/195/-	d/		98/154/241

a/ Source: Gulf, 1981, and Stevens, 1982. Measurements taken during intensive studies each spring and fall at an elevation of nearly 2100 m. Average of several targets.

b/ Source: Vertstuyft, 1982. Radiometer Measurements taken of Flat Tops Wilderness; nephelometer at an elevation of nearly 2600 m. Data is averaged quarterly (i.e., winter is January through March, etc.)

c/ John Muir Institute, n.d. Measurements are taken daily of several targets and adjusted to a standard visual range elevation of 1550 m.

d/ Insufficient data.

e/ Data is presented as 10th/50th/90th percentile values

TABLE III-5
SELECTED, WET ACID DEPOSITION DATA (pH)

	Craig, CO				Douglas Pass				Grand Mesa				Marvine Ranch				Naval oil Shale Res.			
Season	# Obs	Mean	1st Min	2nd Min	# Obs	Mean	1st Min	2nd Min	# Obs	Mean	1st Min	2nd Min	# Obs	Mean	1st Min	2nd Min	# Obs	Mean	1st Min	2nd Min
Spring 1979	2	5.21	5.00	5.63																
Summer 1979	7	4.89	4.48	4.65																
Fall 1979	10	4.79	4.23	4.65																
Winter 1980/81	15	5.10	4.74	4.81	4	5.92	5.50	6.09	12	5.21	4.52	5.00	16	5.25	4.60	4.72	2	5.72	5.64	5.81
Spring 1980/81	26	4.90	4.30	4.33	6	5.14	4.75	5.18	2	5.51	5.27	6.13	7	5.59	4.86	5.47	1	4.93	-	-
Summer 1980/81	21	4.88	4.32	4.45	4	4.63	4.41	4.50	1	5.26	-	-	7	4.81	4.49	4.74	3	5.15	5.03	5.05
Fall 1980/81	17	5.03	4.62	4.70	3	5.66	5.40	5.60	2	5.13	4.88	5.82	5	4.86	4.39	4.85	3	5.09	4.78	5.14
Winter 1982	6	5.43	5.04	5.20																

Sources: National Atmospheric Deposition Porgram, 1980-1982, and Turk, 1982.

TABLE III-6
FREQUENCY OF STABILITY CLASSES AT 500 METERS ABOVE GROUND LEVEL

Station/Season		Morning (percent) Unstable	Neutral	Stable	Afternoon (percent) Unstable	Neutral	Stable
Cathedral Bluffs Tract							
	Annual	10	55	34	19	55	27
	Spring	11	61	28	34	54	12
	Summer	13	51	36	45	32	23
	Fall	10	61	29	17	63	21
	Winter	2	48	50	6	69	25
Craig	Annual	2	39	60	16	64	20
	Spring	5	56	39	31	54	14
	Summer	0	21	80	14	66	20
	Fall	2	37	61	13	69	18
	Winter	0	43	57	6	65	29
Grand Junction	Annual	2	52	46	1	84	15
	Spring	1	68	31	0	96	3
	Summer	0	57	43	0	98	2
	Fall	1	49	50	0	91	9
	Winter	6	33	62	3	51	47

Source: Systems Applications, Inc., 1982. Percentages may not add to 100 percent due to rounding errors.

TABLE III-7
SELECTED MIXING LAYER HEIGHT DATA

Station/Season		Morning (Meters above ground level	Afternoon (Meters above ground level
Grand Junction a/			
	Annual	384	2,600
	Spring	628	3,166
	Summer	307	3,940
	Fall	273	2,133
	Winter	329	1,160
Rio Blanco Tract b/			
	Annual	450	--
	Spring	935	--
	Summer	179	--
	Fall	196	--
	Winter	290	850

a/ Source: Systems Applications, Inc.,1982
b/ Source: Gulf Oil Corporation, 1976

the region, whereas high pressure cells stagnate, blocked by the Rocky Mountains, resulting in moderate temperatures and abundant sunshine. The region's complex topography causes considerable variation in site-specific temperature, precipitation, and winds, but these influences are less on the plateaus than down in the valleys. Severe weather conditions such as tornadoes, floods, damaging hail and winds.

Temperatures vary mostly with elevation, and to a lesser extent, local topography. Generally, summer temperatures range from lows of 7°C (45°F) to highs of 30°C (85°F). Winter temperatures range from -15°C (5°F) to 2°C (35°F). Extreme temperatures may fall as low as -40°C (-40°F) or up to 38°C (100°F). Frost-free periods vary from year to year and by location, but tend to range from 60 to 150 days.

Annual precipitation in the Piceance Basin is highly variable; ranging from 20 to 60 cm (8 to 24 inches), with slightly more than half of the moisture coming from scattered spring and late summer thundershowers. Snowfall amounts vary from 64 to 380 cm (25 to 150 inches); snowcover is commonly redistributed by wind. At lower elevations, limited data indicate evaporation exceeds precipitation, with the driest conditions occurring in mid-summer.

Upper-level winds predominate from the southwest, but surface wind patterns are almost entirely dependent on local terrain and ground cover. Persistent winds with little directional modification are found on the plateaus, but winds in valleys show strong drainage influences (Figure III-2). Synoptic (pressure gradient) winds may be forced around hills or channeled through valleys, but if there is no strong gradient flows, upslope/downslope winds predominate in a diurnal effect.

Upslope winds usually occur on sunny mornings when the air at higher elevations heats rapidly and rises. Downslope winds occur when the air near the ground cools, becomes dense, and sinks downward along drainages. In Piceance Basin, downslope winds are common and stronger than their upslope counterparts.

Air basins have been defined based on these drainage winds, indicating areas of similar atmospheric flow, topographic influence and general dispersion potential. Under stable conditions, pollutants tend to collect and concentrate in an air basin until regional synoptic winds disperse the air between basins. Generally, Piceance Creek downslope winds flow into the Craig Air Basin in the north and the Roan or Parachute Creek downslope winds flow south into the Colorado River Basin (Pedco 1981).

The extent that vertical and horizontal mixing will take place is related to the atmospheric stability and mixing height. Distributions of these factors from selected locations near the study area are presented in Tables III-6 and III-7. Unstable conditions occur under conditions of strong surface heating, typical of summer afternoons producing upslope winds. Neutral conditions reflect a breezy, well-mixed atmosphere. Stable conditions are enhanced by rapid radiative cooling and downslope drainage, producing the least amount of dispersion. Inversions are formed under stable conditions, trapping pollutants within a certain layer of air. In the Piceance Basin, moderate inversions are formed during the summer in the evening and dissipate at dawn.

Winter inversions are stronger and last longer; an episode lasting three to six days may be expected (Bureau of Land Management 1976). Inversions are enhanced by weak pressure gradients, cold clear nights, snowcover and lower elevations.

GEOLOGY AND MINERAL ACTIVITY

The following is a discussion of the geology of Tracts C-11 and C-18, and the mineral resources estimated to occur under each tract. Mineral development activity is currently taking place in the area as described in Chapter II, No Action Alternative.

Structural Geology of Tracts C-11 and C-18

The regional dip is to the north in the eastern part and to the northwest in the western part of the area at a rate of 150 feet per mile. Additional information on the structural geology of the area is included in the *1973 Prototype EIS*.

Figure III-3 presents a general stratigraphic column of both Tracts C-11 and C-18. Figure III-4 is a geologic cross section across Tract C-11 and areas to the west (see Figure III-5 for location of the cross-section). Core hole MMC-IRI No. 1 is located near the southern boundary of Tract C-18. Core hole Square S No. 1 is located one mile east of the east boundary of the tract. Figure III-6 is a geologic cross section through the southeast quadrant of Tract C-18 (see Figure III-5 for location of the cross-section).

The Uinta Formation stratigraphically overlies the Green River Formation. It varies from 1,000 feet to

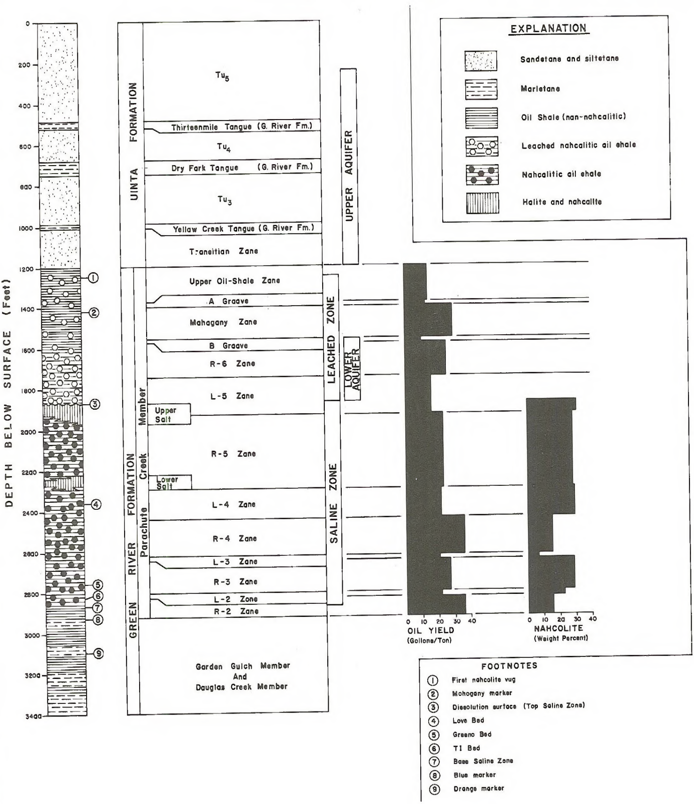


Figure III-3 Detailed Stratigraphic Column of Uinta Formation and Upper Green River Formation for Both Tracts C-11 and C-18 (Multi Mineral Corporation 1981)

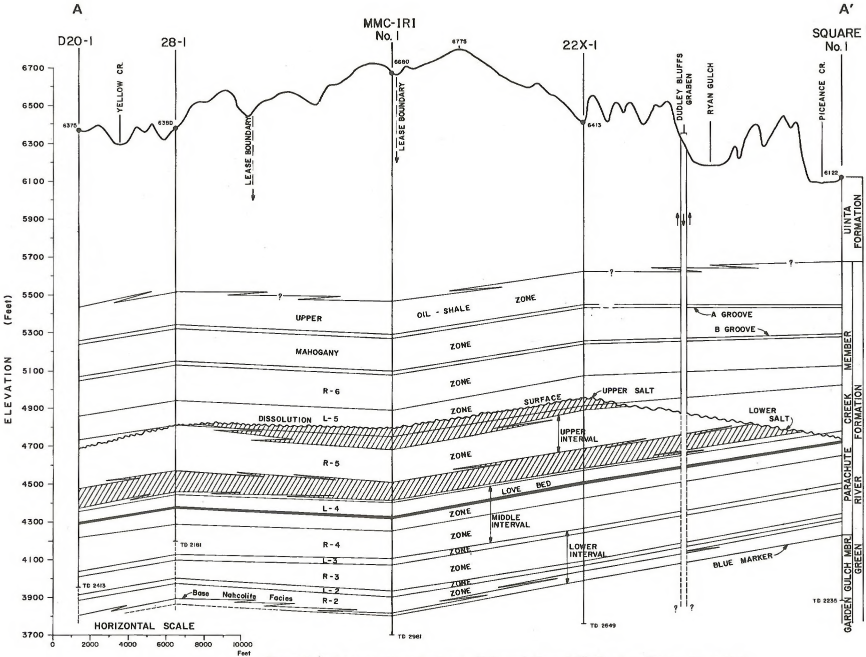


Figure III-4 Structural Cross Section A-A' Through Tract C-11. For Location See Figure III-5 (Multi Mineral Corporation 1981)

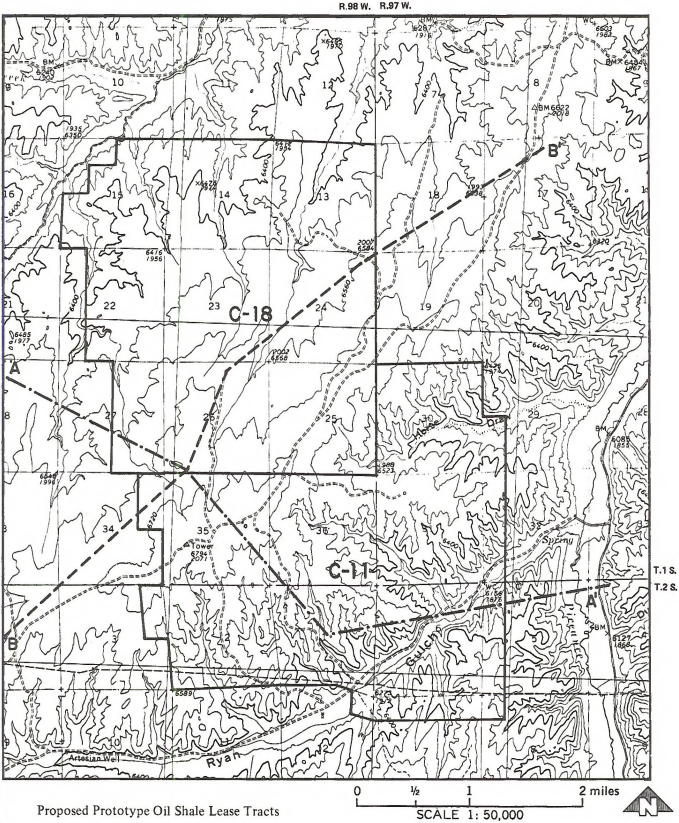


Figure III-5 Location of Stratigraphic Cross Sections. Lines A-A' and B-B' Correspond to Figures III-4 and III-6 (Multi Mineral Corporation 1981)

1,200 feet in thickness and is composed of four major sandstone-siltstone units interbedded with three thin (30 foot thick) marlstone tongues of the Green River Formation. Since the Uinta Formation contains no economic resources, it exists as overburden to the oil-rich Parachute Creek Member of the Green River Formation.

The Parachute Creek Member has been subdivided into alternating units of lean to relatively rich kerogen-bearing strata. The Parachute Creek is also subdivided on the basis of saline minerals. A dissolution surface divides the Parachute Creek Member into two major zones and the saline zone according to the presence or absence of dawsonite, nahcolite, and halite. The dissolution surface (see Figures III-4 and III-6) occurs in the L-5 oil shale zone in the central part of Tract C-18 but drops stratigraphically to the base of the R-5 zone in the southeast part of Tract C-11. This dissolution surface marks the lowest penetration of groundwater into the Parachute Creek Member.

The leached zone, the interval above the dissolution surface and below the upper two thirds of the oil shale rich Mahogany Zone varies from 400 to 600 feet thick and contains rich oil shale beds as well as cavities and collapsed breccias from which nahcolite and halite have been dissolved and subsequently crushed by overburden weight. Below the dissolution surface, the saline zone ranges from 500 to 1,200 feet thick, with the thickest interval found in the northeast quadrant of Tract C-18. The saline zone is composed of coarse aggregate to disseminated nahcolite, and bedded halite and nahcolite interbedded with oil shales. The lower stratigraphic boundary of the saline zone is located approximately 50 feet above the Garden Gulch Member of the Green River Formation.

The Garden Gulch Member averages 150 feet in thickness across the area. It consists mainly of lean, silty marlstone and non-nahcolite bearing oil shale. The base of the Garden Gulch Member marks the base of the oil shale of economic interest (Multi Mineral Corp. 1981).

Mineral Resources of Tract C-11

The proposed Tract C-11 lies over the axis of the South Rangely syncline. The syncline trends northwestward across the tract. The Mahogany Zone dips at approximately 100 feet per mile northeast south of the syncline's axis and southwestward north of the syncline's axis. The Dudley Bluffs graben may extend northwestward across the tract in the subsurface.

This oil shale sequence is not homogeneous in grade from top to bottom, but is comprised of 14 discrete stratigraphic zones of alternating rich and lean shales. Lean zones range from 10 to 20 gal/ton in grade and up to 200 feet in thickness. The richer zones range from 20 to over 30 gal/ton in grade and are from 100 to 225 feet thick.

Important Oil Shale Zones

Beneath the tract, the Mahogany Zone contains oil shale 150 feet thick that averages 30 gal/ton in beds at least 10 feet thick. This zone increases in thickness westward across the tract from approximately 124 feet near the eastern margin to approximately 154 feet near the western margin. In place resources in shales at least 10 feet thick averaging 30 gal/ton are about 300,000 bbls/acre.

In the stratigraphic lower part of the Green River Formation (R-1 through R-6), containing both the leached and saline zones, oil shale averaging 30 gal/ton in beds at least 10 feet thick is approximately 750 feet thick. In place resources in these shales are 1,500,000 bbls/acre.

Tract C-11 may contain total in place oil shale resources of approximately 1,800,000 bbls/acre (intervals at least 10 feet thick average 30 gal/ton). The total in place resource in beds at least ten feet thick and averaging 30 gal/ton may be approximately 9,200,000,000 barrels. Based on direct mining technologies tested elsewhere in the basin, approximately 2,590,000,000 equivalent barrels of shale oil might be recovered. Recovery estimate does not include the leached zone, as generally poor ground conditions caused by solution cavities and brecciation would severely limit application of direct mining methods.

Important Sodium Zones

The stratigraphic lower parts of the Green River Formation may contain significant quantities of sodium resources (R-5 through R-3) in the saline zone. At least 750,000 tons of nahcolite per acre and at least 180,000 tons of dawsonite per acre may be present under Tract C-11.

Total sodium resource beneath Tract C-11 may exceed 3,840,000,000 tons of nahcolite and 922,000,000 tons of dawsonite. Approximately 614,000,000 tons of nahcolite and 155,000,000 tons of dawsonite may be recovered from Tract C-11.

Mineral Resources of Tract C-18

Tract C-18 lies over an extension of the South Rangely Syncline. The axis trends westward across the tract. The Mahogany Zone dips inward from the margins of the tract at about 75 to 100 feet per mile. Numerous fractures have been maped on the tract, but no evidence of faulting has been observed. The Mahogany Zone is approximately 160 to 180 feet thick on the tract, lies at 5,200 to 5,300 feet above sea level, and averages 25 to 30 gal/ton.

The oil shale interval is not homogeneous in grade from top to bottom, but is comprised of 13 discrete stratigraphic zones of alternating rich and lean shale. Lean zones average from 10 to 20 gal/ton in grade and 30 to 150 feet in thickness. Rich zones average from 20 to over 30 gal/ton in grade and 75 to 225 feet in thickness.

Sodium mineralization, including the minerals nahcolite and dawsonite, occurs in the saline zone interbedded with both lean and rich oil shales.

Important Oil Shale Zones

In the Mahogany Zone, oil shales yielding 30 gal/ton in intervals thicker than 10 feet are 141 feet thick. In place oil resources are approximately 287,000 bbl/acre.

Oil shales averaging 30 gal/ton in beds greater than 10 feet thick are present in the Parachute Creek Member of the Green River Formation below the Mahogany Zone (R-6 Zone) which is approximately 400 feet thick. This part of the stratigraphic section contains in place resources of approximately 213,000 bbls/acre.

The stratigraphically lowest part of the Green River Formation (Saline Zone) may contain oil shales averaging 30 gal/ton in beds 10 feet or more thick. In place resources in this interval are approximately 1,500,000 bbls/acre.

The tract contains total in place oil shale resources of approximately 2,000,000 bbls/acre. Total resources in beds at least 10 feet thick that average 30 gal/ton with approximately 10,240,000,000 barrels under the entire tract. Based on demonstrated direct mining technologies, up to approximately 2,297,000,000 equivalent barrels of shale oil might be recovered from the tract. As for C-11, recovery estimates do not include production from the leached zone due to poor ground conditions that would significantly limit application of direct mining methods.

Important Sodium Zones

The saline zone is divided into the Upper Salt and Lower Salt Zones. The Upper Salt Zone contains dominantly massive halite beds with some nahcolite and ranges from 30 to 100 feet in thickness. The Lower Salt Zone averages 20 feet in thickness. It contains thick nahcolite beds and five to ten foot thick nahcolite oil shale beds. The Love Bed within the L-4 Zone of the Parachute Creek Member contains the richest nahcolite deposits. Dawsonite occurs in bedded deposits throughout the saline zone. Under Tract C-18, the Green River Formation may contain up to 800,000 tons of nahcolite per acre and may contain up to 200,000 tons of dawsonite per acre.

Sodium resources beneath C-18 may be as much as 4,100,000,000 tons of nahcolite and 1,000,000,000 tons of dawsonite. Direct mining might recover as much as 564,000,000 tons of nahcolite and 172,000,000 tons of dawsonite.

Mining and Processing Technologies

Direct Mining

Direct underground mining for coal, trona, and other bedded soft-rock deposits allows 50 to 75 percent recovery rates within the interval being mined depending upon ground conditions that dictate pillar strengths and maximum size of stable mine openings. Estimated oil shale recovery by room-and-pillar mining on Tract C-b according to the detailed development plan (submitted by Ashland Oil Company in 1979) is only 30 to 50 percent of the shale in a 75 foot thick interval but only about 20 percent for the entire thickness of potentially mineable shale within and about the Mahogany Zone (see Figure III-7).

Many of the modern oil shale room-and-pillar mine designs are patterned after the design developed by the U.S. Bureau of Mines. From Bureau studies it was concluded that 60 foot rooms with 60 foot square pillars would maximize resource recovery, prevent subsidence, and provide a safe working place. Recoveries using this mine design will approach 70 percent if the full thickness of the ore zone can be mined. For additional information on direct mining processing see Chapter II.

Mine Assisted In-Situ

In mine assisted in-situ processing, the permeability of the oil shale is increased by mining about

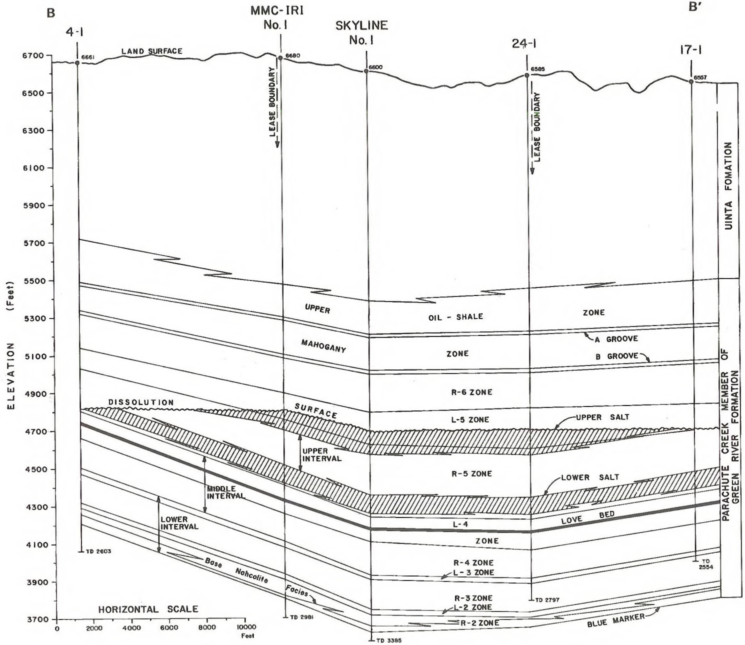
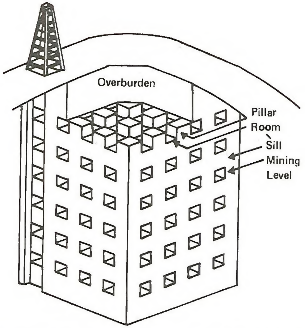
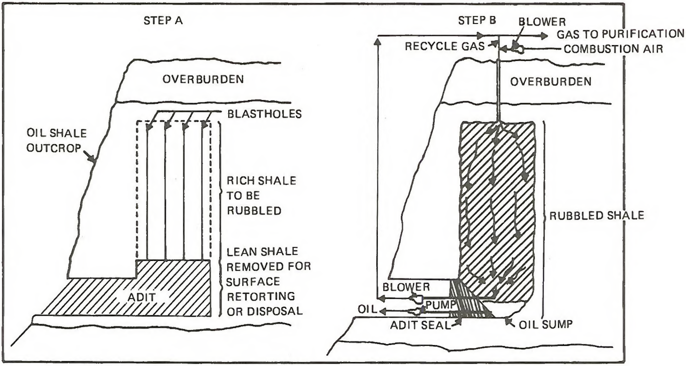


Figure III-6 Structural Cross Section B-B' Through the Southeast Quadrant of Tract C-18. For Location See Figure III-5 (Multi Mineral Corporation 1981)



SOURCE *Hearing on Oil Shale Leasing* Subcommittee on Minerals, Materials, and Fuels of the Senate Committee on Interior and Insular Affairs. 94th Cong. 2d sess. Mar. 17, 1976. p 83

Figure III-7 Room and Pillar Mining on Multiple Levels (Congressional Office of Technology Assessment 1981)



SOURCE T. A. Sladek. "Recent Trends in Oil Shale—Part 2. Mining and Oil Shale Extraction Processes. "*Mineral Industries Bulletin*. Vol. 18. No. 1 January 1975. p 18

Figure III-8 Modified In-Situ Retorting (Congressional Office of Technology Assessment 1981)

20 to 40 percent of the oil shale from the deposit on multiple mine levels and then blasting the remainder into the mine voids to create rubble filled chambers. The two step process is illustrated in Figure III-8. As the retort is pyrolyzed, oil and gas vapors are collected in a sump at the bottom of the retort and pumped to the surface. Mine assisted in-situ technology has been demonstrated by Occidental Oil Shale, Inc. at their Logan Wash property and at Tract C-a by Rio Blanco Oil Shale Company. Uniform fragmentation is a key and difficult to achieve requirement for efficient retorting. Integrated in-situ technology for recovering shale oil, nahcolite, alumina and soda ash has been proposed by Multi Mineral Corporation for the saline zone in the Piceance Creek Basin (see Chapter II). Its overall oil shale recovery efficiency is similar to that described above plus sequential extraction of nahcolite and alumina. For additional information on mine assisted in-situ see Chapter II.

True In-Situ

Geokinetics has been investigating in-situ retorting of shallow oil shale in Utah since 1973. True in-situ technology like that of Geokinetics can only be applied to shallow shale despists with less than 500 feet of overburden and will not be considered for these tracts. However, Equity Oil Co. in cooperation with the Dept. of Energy has been conducting true in-situ solution mining below the Mahogany Zone at depths of 775 to 1,325 feet (in the leached zone). Here superheated steam is forced through a system of boreholes underground. The steam circulates through the natural porosity of the leached zone retorting the oil shale. Shale oil is then pumped to the surface through stratigically located producer wells as an oil-water emulsion for surface separation. Problems of maintaining borehole alignment and loss of product to the formation, render this process quite inefficient. For more information on true in-situ see Chapter II.

TOPOGRAPHY

Tracts C-11 and C-18 are located near the center of Piceance Basin, a 1,600 square mile elevated structural basin. Within the basin lies a dissected plateau with relief diminishing from south to north. Elevation in the south is more than 9,000 feet and ranges to 5,000 feet above sea level at the northern edge.

Both tracts are located on Bar D Mesa, a dissected plateau with gently rolling slopes of three to seven percent. Elevation of the tracts ranges from 6,100 feet along Yellow and Piceance Creeks to 6,794 feet on top of the mesa. Total relief is approximately 700 feet. Drainages dissecting into the mesa generally range in slope from 14 to 17 percent on northern aspects to 36 to 100 percent on southern aspects. Drainage of the tracts is trellis to parallel, reflecting the influence of bedrock jointing.

Tract C-11 is located on the southern aspect of Bar D Mesa. The southeast and northeast corners of the tract are dissected by Ryan Gulch and Horse Draw, respectively. Those portions of the tract immediately on the south sides of those two drainages provide the only predominant northern exposure on the tract. Being on the south side of Bar D Mesa, C-11 is much more dissected by ephemeral tributary drainages (of Ryan Gulch and Horse Draw) than Tract C-18. Tract C-11 land area is evenly divided between gentle slopes of three to seven percent to steeply sloping hillsides of the tributary drainages of 36 to 100 percent slopes.

Tract C-18 is located on the northern aspect of Bar D Mesa. This tract is dissected by tributaries of Yellow Creek that drain northward. The tract has only a small portion of southern exposure in the far southeast corner of the tract and contains the upper portion of Horse Draw. The majority of Tract C-18 is gently sloping with slopes of two to ten percent.

FLOODPLAINS

Floodplains within the lease tract areas occur along Ryan Gulch and Yellow Creek. The potential for flooding exists throughout the basin, with the major events resulting from high intensity localized thunderstorms. Runoff from these storms can be quite high as evident by a 6,800 cubic feet per second (cfs) instantaneous discharge measured at Yellow Creek near White River Station on September 7, 1978. The US Army Corps of Engineers has analyzed portions of the Yellow Creek and Ryan Gulch floodplains. Their floodplain delineations as shown in Figure III-9 are based upon a 100 year floodplain and a minimum watershed of five square miles.

The extreme northwest corner of Tract C-18 is located immediately adjacent to and possibly in the 100 year floodplain of Yellow Creek. Ryan Gulch runs diagonally through the southeastern part of Tract C-11. While the drainage area of Ryan Gulch is quite small, the potential for flooding does exist.

ALLUVIAL VALLEYS

Alluvial valleys are associated with the major drainages in Piceance Basin. These are topographically low areas which have a thick mantle of unconsolidated sediments (colluvium and alluvium) and receive additional runoff moisture from upland areas. This additional moisture and the generally gentle slopes make some of these alluvial valleys suitable for subirrigated or flood irrigated agricultural production (principally hay meadows).

Most of the irrigated alluvial valleys in Piceance Basin are used for hay production which is of vital importance to the local livestock industry. Hay production makes it possible for livestock operators to feed their herds when no other forage is available during the winter months. Some alluvial valleys, which have not been developed for agricultural use, produce riparian vegetation which is important to wildlife.

On Tract C-11, Ryan Gulch and Horse Draw have alluvial valleys associated along their lengths which occupy about 580 acres (11 percent of the tract). They have not been developed for agriculture and do not have extensive areas of riparian vegetation. On Tract C-18, about 130 acres (2 percent of the tract) of alluvial valley is found associated with drainages which are tributary to Yellow Creek. A very small (5 acre) portion of this could be used for agricultural production. Adjacent to the tracts, alluvial valleys are associated with Yellow Creek and Piceance Creek. Portions of these alluvial valleys have been developed for agriculture.

AGRICULTURAL LANDS

Agricultural land is all land that produces agricultural commodities. Agricultural land varies greatly in productivity and includes cropland, rangeland and woodland. Cropland is generally the most productive agricultural land which is periodically tilled and planted to a specific economic plant. Generally, cropland is harvested by mechanical means. Cropland in Rio Blanco, Garfield and Mesa Counties may or may not be irrigated. Rangeland is agricultural land that is generally less productive than cropland. Rangeland is rarely tilled and most production is from native perennial plants. Generally, rangeland is harvested by livestock. In this area, rangeland is important wildlife habitat as well. For the purposes of this discussion, woodland is included as a portion of rangeland because forage for grazing animals is an economically and biologically important product of woodlands.

In this area, livestock production is the primary agricultural activity. Most cropland is used to produce winter feed for livestock, while rangelands are used during the spring, summer, and fall. Therefore, the dominant agricultural activity depends upon the availability of both cropland and rangeland (see Chapter III, Vegetation-Grazing).

Based on acreage planted in 1979 and conversations with local Soil Conservation Service officials, the following amounts of cropland are available in the area:

Rio Blanco County -- 68,500 acres

Garfield County -- 98,600 acres

Mesa County -- 84,500 acres

No croplands, prime farmlands or unique farmlands are present within the tract boundaries (SCS 1982). The only agricultural use of the tracts is grazing of rangelands. However, irrigated pasture land and hayland of statewide importance occurs in adjacent off-tract locations within the drainages of Piceance, Black Sulphur and Yellow Creeks, and the White River. Prime farmlands are also located in scattered segments along Piceance Creek from Hunter Creek to Dry Fork, and along the White River from Meeker west through Powell Park. No unique farmlands are present within the county.

SOILS

Introduction

The soils within the tracts were mapped to Order III by the Soil Conservation Service (Soil Survey of Rio Blanco County, USDA SCS, in press). Location of Soil Mapping Units are shown on Figure III-10.

This Order III soil survey was mapped on a base of 1:24,000. The minimum sized cartographic unit at this scale is about six acres in size. Mapping units are not taxonomically pure; soils other than the named soil will occur within the map unit. These other soils are called inclusions and are generally not of large extent. This soil survey was designed to provide rangeland interpretations and a base for land use planning. It is adequate for these uses, however development of a detailed mine plan would require a more detailed soil survey designed to provide specific interpretations for engineering and reclamation.

These soils are generally cold (mean annual soil temperature of less than 8°Centigrade) and are dry a large portion of the time that soil temperatures are warm enough for plant growth.

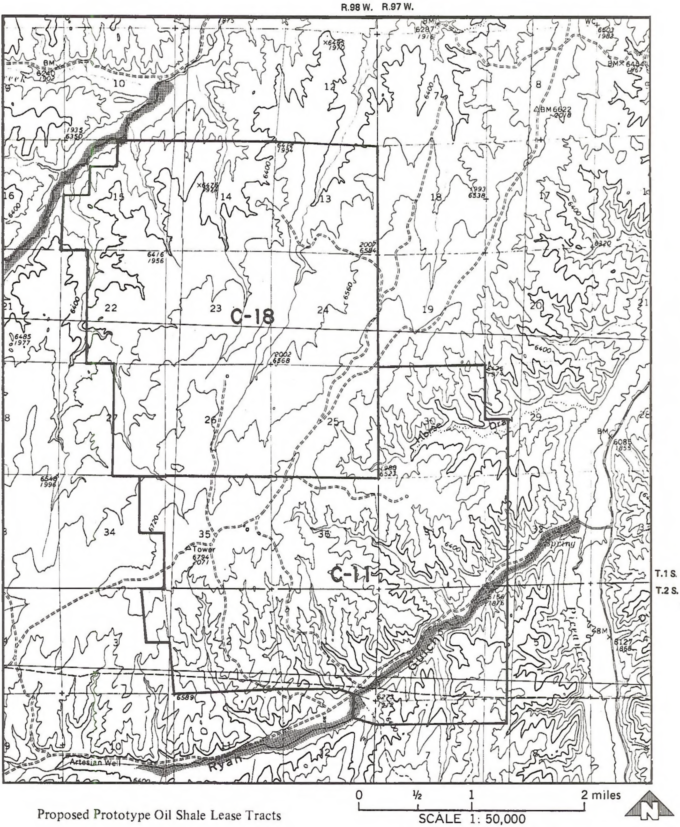


Figure III-9 Extent of Floodplains of Ryan Gulch and Yellow Creek, Based Upon 100 Year Floodplain Limits

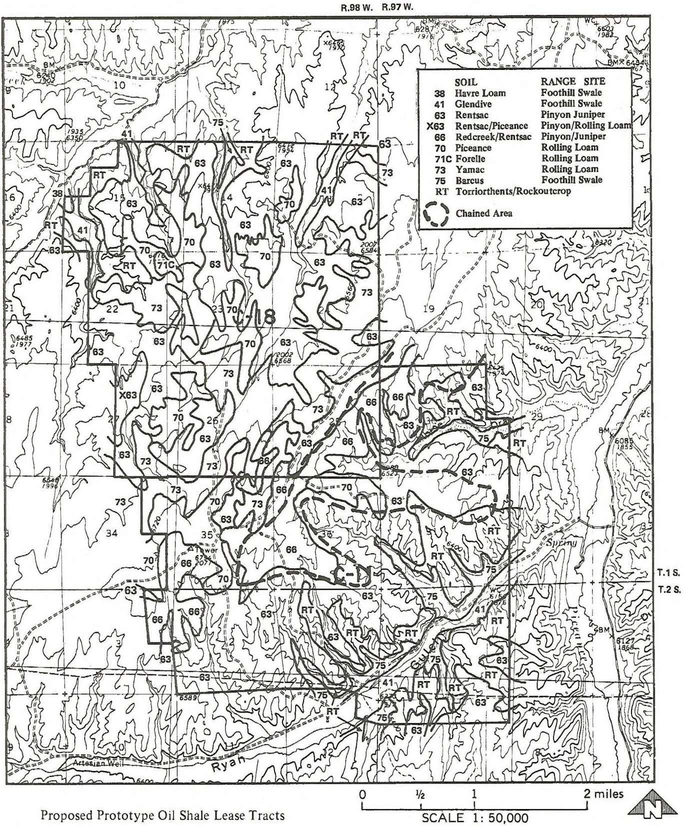


Figure III-10 Soil and Range Sites of Tracts C-11 and C-18

Soil Descriptions

The following is a technical description of some characteristics of the soil map units shown in Figure III-10 by their topographic location.

Sideslope Soils

Two map units have been identified on sideslope positions. Unit 63 is Rentsac channery sandy loam, 5 to 50 percent slopes. (Channery indicates the soil surface has between 15 and 35 percent by volume of gravel or cobble sized rock fragments (channers) that are much smaller in one dimension than in the other two dimensions. A channer is a small flagstone.) Unit RT is a Torriorthents-Rock Outcrop Complex which is excessively drained, gravelly cobble on 15 to 90 percent slopes.

Rentsac soils are less than 20 inches deep to hard bedrock and are dominantly very channery sandy loam in texture. Torriorthents-Rock Outcrop complex is an intricately intermixed grouping of weakly developed soils (about 60 percent of the unit) and rockoutcrop (about 40 percent of the unit).

Bottomland Soils

Three map units have been identified in bottomland positions. Unit 75 is Barcus channery loamy sand, 2 to 8 percent slopes. Unit 41 is Glendive fine sandy loam, 2 to 15 percent slopes. Unit 38 is Havre loam, 0 to 3 percent slopes. These soils are all receiving sediment more rapidly than they are forming diagnostic horizons. All of these soils are at least 60 inches thick.

Barcus soils are dominantly channery sand or channery loamy sand in texture and somewhat excessively well drained. Glendive soils are dominantly fine sandy loam in texture and well drained. Havre soils are dominantly loam and silty clay loam in texture. Havre soils are strongly alkaline below a depth of about 25 inches.

Upland Soils

Five map units have been identified on upland positions. Unit 71C is Forelle loam, 3 to 8 percent slopes. Unit 70 is Piceance fine sandy loam, 5 to 15 percent slopes. Unit 66 is the Redcreek-Rentsac complex, 5 to 30 percent slopes. Unit X63 is the Rentsac-Piceance complex, 2 to 30 percent slopes. Unit 73 is Yamac loam, 2 to 15 percent slopes.

Forelle soils and Yamac soils are dominantly loam and clay loam in texture, are well drained, and are about 60 inches thick. Piceance soils are dominantly sandy loam and loam in texture, are well drained, and are 20 to 40 inches thick over hard bedrock. The Redcreek-Rentsac complex is an intricately intermixed grouping of Redcreek soils (about 60 percent of the unit) and Rentsac soils (about 30 percent of the unit). Redcreek soils are dominantly sandy loam in texture, are well drained, and less than 20 inches thick over hard bedrock. Rentsac soils are similar to those Rentsac soils which have been previously described. The Rentsac-Piceance complex is an intricately intermixed grouping of Rentsac soils (about 60 percent of the unit) and Piceance Soils (about 30 percent of the unit). These soils are similar to the Rentsac soils and Piceance soils which have been previously described.

Soil Moisture

In the semiarid environment, water limits plant growth. In this environment, the ability of a soil to hold moisture is at least as important as nutrient availability. Finer textured soils (loams and clay loams) are more effective at holding moisture than coarser textured soils (sandy loams, channery sandy loams, and very channery sandy loams). Soils on steep slopes will generate more runoff than gently sloping soils. This runoff is not available to plants on the site from which it runs off, however bottomland soils receive additional moisture from runoff. Because of these soil moisture relationships, the bottomland soils are more productive than are the sideslope or upland soils as the bottom land soils have more moisture than is available from precipitation. The upland soils are more productive than the sideslopes because they generate less runoff than the sideslope soils. Also these upland soils are generally of a finer texture and are more effective at holding moisture than are the sideslope soils.

Soil Erosion

Soil erosion is controlled by many factors including climate, plant cover, length and steepness of slope, inherent erodibility of the soil and land use. Of these factors, land use and plant cover are most directly under human control. By reducing plant cover or changing land use, management can ac-

celerate erosion above natural rates. This can cause reduction in productivity of the eroded site and downstream sedimentation problems. The weighted average erosion rate for Tract C-11 is 3.4 tons per acre per year and for Tract C-18 is 2.8 tons per acre per year using the universal soil loss equation (USDA 1978). This is an estimate of sheet and rill erosion. These soil loss estimates cannot be directly converted to sediment yields because they do not include gully or channel erosion nor do they account for deposition of material prior to its entrance to perennial water courses (see Chapter III, Hydrology). Table III-8 shows acreage and estimated erosion rates by soil map unit for the oil shale lease tracts.

HYDROLOGY

Groundwater Quantity

Groundwater occurs throughout Piceance Basin. The principal water bearing strata within the basin are the Uinta and Green River Formation (see Figure III-11) with the Green River Formation being the most important. The aquifer system is roughly divided into an upper and lower aquifer system. These two systems are separated by a less permeable oil shale rich zone known as the Mahogany Zone. Estimates of groundwater storage of the basin range up to 25 million acre feet, (International Engineering Company Inc. 1981).

The average depth to water in the upper aquifer at C-11 and C-18 is approximately 300 feet. Wells in the upper aquifer yield as much as 300 gal/min., but yields of less than 100 gal/min are more common (Fox October 1980). Permeability is primarily due to fracturing. Transmissivities within the proposed lease tracts average 668 ft² per day

The upper and lower aquifers are separated by a relatively impermeable stratum known as the Mahogany Zone. The Mahogany Zone is locally fractured, and permits same degree of vertical exchange of water between the aquifers. The vertical hydraulic conductivity has not been adequately determined, but estimates place it as large as 0.37 feet per day (Weeks et al 1974). However, the Mahogany Zone in Tracts C-11 and C-18 is located in a transission zone between recharge and discharge areas of the upper and lower aquifers with near equal hydraulic head pressure.

Wells developed within the lower aquifer yield as much as 1,000 gal/min, but 200 to 400 gal/min is more typical. Based on limited testing, the transmissivities of the lower aquifer within the proposed lease tracts are less than those of the upper aquifer (Multi Minerals Corporation 1981). This is not generally the case throughout the basin. Transmissivities of the lower aquifer within the leached zone are usually greater than the upper aquifer.

Alluvial aquifers are also present within the basin. The areal extent of these aquifers is limited to the valley bottoms along the major creeks. The total available water in the alluvial system is small compared to the other aquifers, however, the alluvial system acts as the interface between streamflow, runoff, and groundwater recharge.

Recharge to the aquifer system occurs primarily from snowmelt in the upper elevations. In the area of recharge, part of the water moves from the upper aquifer through the Mahogany Zone to the lower aquifer (Weeks et al 1974). Groundwater flow is generally from the recharge areas at the basin margins to the discharge areas in the north central portion. The proposed lease tracts appear to be located within the discharge areas.

Groundwater outflow from the system is upward from the lower aquifer through the Mahogany Zone to the upper aquifer. Water is then discharged to the streams from the upper aquifer through the alluvium or springs. Groundwater is lost from the basin by evapotranspiration or discharge from Piceance and Yellow Creeks. According to Weeks et al (1974), no significant amount of groundwater discharges to the White River directly from the Green River Formation, except through Piceance and Yellow Creeks.

Current use of groundwater within the basin is minimal. Groundwater discharge accounts for over half the base flow in the major basin drainages and is indirectly the primary source of water for hay meadow irrigation and animal use along the major drainages. Other groundwater uses are for domestic and livestock watering wells. There are numerous springs and seeps which supply water for livestock and wildlife. Because of the large number of springs in the basin, the reader is referred to a report prepared for the Colorado State Engineer by the U.S. Geological Survey entitled *Piceance Basin Spring Hydraulics Investigation*.

Groundwater Quality

Very little site-specific groundwater quality data has been collected on the tracts. The following is a general description of the basin as a whole, with site-specific data presented where available.

TABLE III-8
SOIL MAP UNIT ACREAGE AND EROSION RATES

Soil Map Unit	Tract C-11 Acres 1/	Tract C-11 Soil Loss 2/ Tons/Acre/Year	Tract C-18 Acres 1/	Tract C-18 Soil Loss 2/ Tons/Acre/Year
75 - Barcus	350	0.15	20	0.15
71C - Forelle	--	--	20	0.09
41 - Glendive	230	0.08	100	0.08
38 - Havre	--	--	10	0.01
70 - Piceance	300	0.4	550	0.4
66 - Redcreek/Rentsac	650	2.1	230	2.1
63 - Rentsac	2,420	4.6	2,470	4.6
X63 - Rentsac/ Piceance	--	--	70	2.0
RT - Torriorthents/ Rock Outcrop	1,020	4.7	350	4.7
73 Yamac	150	0.4	1,300	0.4

1/ Acreage numbers have been rounded to the nearest ten acres.

2/ Estimates generated by the universal soil loss equation (USDA 1978).

TABLE III-9
CHARACTERISTICS OF MAJOR STREAMS

Characteristics	White River Near Ouray, UT	Piceance Creek at White River	Yellow Creek Near White River
Drainage Area (Square miles)	5,120	652	262
Average Annual discharge (cfs) 1/	241,880	10,518	660
Maximum Daily Discharge (cfs) 1/	4,200	186	500
Minimum Daily Discharge (cfs) 1/	110	0.70	0
Average Daily discharge (cfs) 1/	662	28.8	1.81
Maximum Instantaneous discharge (cfs) 1/	4,260	628	6,800
1980 Sediment Discharge (tons) 2/	2,046,110	56,115	12,495
Maximum Daily Sediment Discharge (tons/day) 1/	268,000	2,900	90,000
Minimum Daily Sediment discharge (tons/day) 1/	0.69	0.10	0
Maximum TDS (milligrams per liter) 1980 2/	702	1,710	2,090
Minimum TDs (milligrams per liter) 1980 2/	261	731	489

1/ For the period 1975-1980.

2/ 1980 water year.

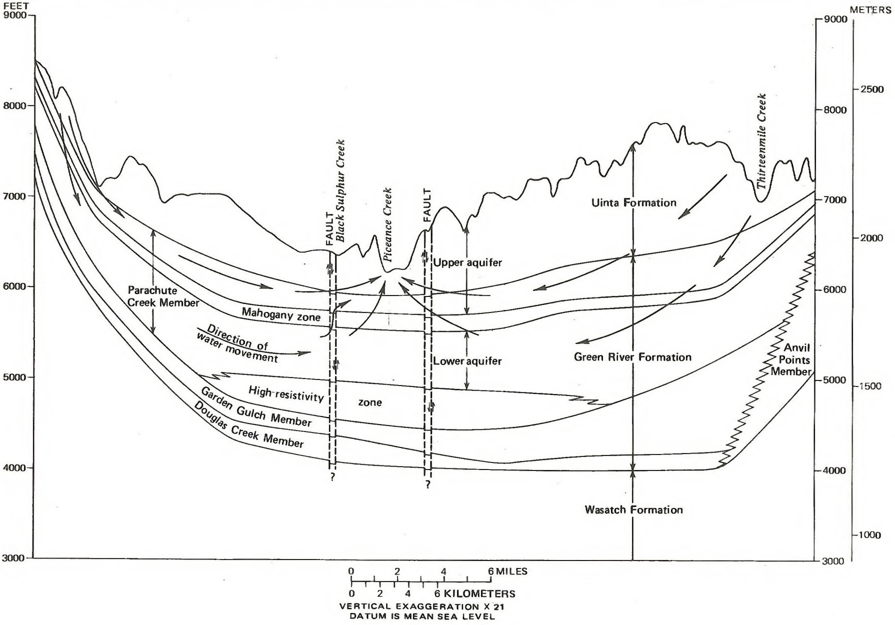


Figure III-11 Geohydrologic Section Through the Piceance Basin Showing Relation of the Aquifers to the Green River and Uinta Formations (Weeks et al 1974)

The groundwater quality of Piceance Basin varies between aquifers, and also by location. In general, water in the upper aquifer is of better quality than the lower aquifers. In addition the groundwater in the recharge areas is of better quality than the discharge areas. As mentioned in the Groundwater Quantity section, the proposed lease tracts appear to be located in the discharge area.

The water in the upper aquifer may be classified as a sodium bicarbonate type. Dissolved solid concentrations for the upper aquifer vary from 400 milligrams per liter (mg/l) to 2,000 mg/l. Calcium, magnesium and sulfate concentrations in the upper aquifer are greater than the lower. Water quality samples obtained from the upper aquifer in the vicinity of the proposed lease tracts have total dissolved solid concentrations which vary from 612 to 1020 mg/l.

The total dissolved solids of the lower aquifer vary from 500 mg/l to nearly 40,000 mg/l. Dissolved-solids concentrations of 63,000 mg/l have been reported from a sample obtained from the high resistivity zone (Weeks et al 1974). Samples taken near the potential lease tracts indicate that dissolved solid concentrations vary from 650 to 9,610 mg/l with most in the 1,000 mg/l range. The lower aquifer water can be classified as a sodium bicarbonate type.

The lower aquifer has higher concentrations of chloride and much higher fluoride concentrations than the upper aquifer. The fluoride concentrations in the lower aquifer are worth noting. The average fluoride concentration for 27 wells sampled in the Basin is 28 mg/l. It is rare to have fluoride concentrations greater than 10 mg/l. Like the upper aquifer, lower aquifer water in the north central portion of the basin is of poorer quality than that of the basin margins.

The concentration of some trace elements within the lower aquifer are great enough to be of environmental concern. Concentrations of barium, boron and lithium are consistently high in the northern part of the basin, indicating that minerals of these elements may be associated with the nahcolite and halite (Weeks et al 1974). Concentrations of barium exceed drinking water standards in 7 out of 11 wells sampled by Weeks et al. The boron and lithium levels are high enough to be toxic to most plants.

Surface Water Quantity

The White River which drains the study area is tributary to the Green River, a tributary to the Colorado River. Piceance and Yellow Creeks, the two major drainages of the Piceance hydrologic basin, are tributaries to the White River. The proposed lease Tracts C-11 and C-18 are located between Piceance and Yellow Creeks, and drain into them.

The primary source of streamflow to both Piceance and Yellow Creeks is groundwater discharge. Recharge of the groundwater system is principally from snowmelt. Precipitation accumulates during the months of November through March at higher elevations and produces a period of high recharge and high streamflow beginning in March to April and continues through June or July. Streamflow for the remainder of the year is maintained almost totally by groundwater discharge, with approximately 80 percent of the surface runoff in the basin being supplied by groundwater, (Robson 1981). Because evapotranspiration rates are extremely high during the summer months, only high intensity thunderstorms produce any significant contributions to summer streamflows.

Table III-9 is a tabulation of the major streamflow characteristics of the area. The White River near Ouray, Utah streamflow station is close to the confluence of the White and Green Rivers. The drainage area of this station is approximately 5,120 square miles. The average annual discharge for the 1975 to 1980 water year is 241,880 cubic feet per second (cfs) (480,000 acre-feet). Average daily discharge for the period of record is 662 cfs with a daily minimum and maximum of 110 and 4,200 cfs respectively. In addition a long-term (1923-1977) gage record on the White River near Watson, Utah shows that the average annual flow is 693 cfs (502,100 acre-feet) with extremes of flow ranging from 11 cubic feet per second (December 1972) to 8,160 cubic feet per second (July 1929). The average flow of the White River above Rangely was 475,300 acre-feet for the period 1972-1980.

The drainage area of Piceance Creek is 652 sq. mi. which is 13 percent of the White River basin. Average annual flow of the Piceance Creek at the White River steamflow station is 18,330 acre feet (12 year record) or about 4 percent of the average annual flow of the White River. Minimum and maximum daily discharges for the period 1975-80 are 0.70 and 186 cfs respectively. Maximum instantaneous peak flow for Piceance Creek was 628 cfs.

Yellow Creek is the smaller of the two streams within the Piceance hydrologic basin. The drainage area measured at the Yellow Creek near White River streamflow station is 262 sq. mi. Average annual discharge is 660 cfs with a maximum daily flow of 500 cfs. A flood peak of 6,800 cfs occurred during 1978. As can be seen from Table III-9, Yellow Creek has experienced a few short periods of no flow.

Surface Water Quality

The surface water quality of both Piceance and Yellow Creeks can be classified as a mixed bicarbonate type in the upper reaches, and a sodium bicarbonate in the lower reaches. The concentration of dissolved solids, fluoride and sodium increase in the downstream direction. Irrigation return flows, evapotranspiration, and groundwater discharge from both the Uinta and Green River formations are the main cause of the water quality degradation in Piceance Creek. Increases in the water quality constituents for Yellow Creek are attributed primarily to groundwater inflows.

Total dissolved solid (TDS) concentrations for both Piceance and Yellow Creeks vary substantially with streamflows. When streamflows are high, (snowmelt periods) TDS concentrations are the lowest. The increases in TDS during low flow conditions are good indications of the discharging of groundwater to the streamflows of both Piceance and Yellow Creeks. Table III-9 displays the maximum and minimum TDS in mg/l for Piceance and Yellow Creeks for the water year 1980, for the days sampled. Yellow Creek has a TDS range of 489 to 2,090 mg/l, while Piceance Creek varies from 731 to 1,710 mg/l. The total dissolved solids of the White River are much lower than the water it receives from both Piceance and Yellow Creeks due to a dilution effect caused by better quality upstream water on the main stem. Total dissolved solids measured at the White River near Ouray station vary from a minimum of 261 mg/l to a maximum of 702 mg/l.

Sediment yields from Piceance and Yellow Creeks are quite high. The annual sediment yield of Piceance Creek for water year 1980 were 56,115 tons (86 tons/square mile), (Table III-9). Extremes for the period 1976-80 vary from a daily minimum of 0.10 tons to a daily maximum of 2,900 tons. Daily extremes for Yellow Creek for the same period of record vary from 0 to 90,000 tons. Annual sediment yields for Yellow Creek for the water year 1980 were 12,495 tons (48 tons/square mile). Sediment yields for the White River as measured near the Ouray, Utah station are 2,046,110 tons/year (400 tons/square mile) for water year 1980. Sediment yields for the White River range from 0.69 to 268,000 tons/day for the 1975-80 period.

VEGETATION

Types

The major vegetation types in the White River Resource Area are pinyon-juniper (33 percent), sagebrush (31 percent), mountain shrub (15 percent), waste land (8 percent), grassland (3 percent), greasewood (3 percent), and saltbrush (4 percent). These vegetation types occur on approximately 1.5 million acres of land. In discussing the oil shale lease tracts these vegetation types will be described in terms of range sites developed by the Soil Conservation Service (SCS 1978).

The area being considered for oil shale leasing consists of foothill swale range sites; rolling loam range sites; rocky and mountain pinyon-juniper woodland sites; and a broadly defined group of soils, which support sparse pinyon-juniper and sagebrush overstory. No riparian vegetation or wetland habitats are known to exist within the tract boundaries.

Most of the foothills swale site exists in Ryan Gulch. The side slopes between Ryan Gulch and the top of the mesa consist of rocky pinyon-juniper woodland sites, and sparse overstories of pinyon-juniper and sagebrush on broadly defined soils. The top of the mesa consists of rolling loam range sites and rocky and mountain pinyon-juniper woodland sites (Figure III-10).

Range sites in Tract C-11 occur in the following percentages:

Foothills swale 10

Rolling loam 20

Rocky Pinyon-Juniper 35 (300 acres chained)

Broadly defined group 10

Mountain Pinyon-Juniper 25 (400 acres chained)

Range sites in the C-18 Tract occur in the following percentages:

Foothills swale 2

Rolling Loam 33

Rocky Pinyon-Juniper 35

Broadly defined group 5

Mountain Pinyon-Juniper 25 (500 acres chained)

These range sites are discussed below based on the present plant community species and production.

Foothills Swale

This range site is a shrub community with a fair understory of grasses and forbs. The principal plant species consist of western wheatgrass, needle-and-thread, bluegrass, and a variety of annual forbs with a moderately dense overstory of big sagebrush and greasewood. Composition by weight of annual production for grasses, forbs and shrubs is approximately 49, 11 and 40 percent, respectively. Estimated ground cover is 25 to 30 percent. This site is presently producing approximately 700 lbs/acre of herbage annually.

Rolling Loam

This range site is a moderately dense stand of shrubs with a sparse understory of forbs and grasses. The principal plant species are western wheatgrass, needle-and-thread, bluegrass, and a variety of forbs, with an overstory of big sagebrush, greasewood and scattered juniper stands. Estimated ground cover is 20 to 25 percent. This site is presently producing 350 lbs/acre of herbage annually.

Mountain Pinyon-Juniper

This range site is a pinyon-juniper woodland situation with sparse grass, forb and shrub production. The principal plant species are Sandberg bluegrass, slender wheatgrass, western wheatgrass, big sagebrush and bitterbrush. The overstory is again dominated by juniper with scattered pinyon. Vegetation ground cover is between 10 and 15 percent. Tree canopy cover can range from 70 to 80 percent. The average annual herbaceous production is 300 lbs/acre.

Approximately 900 acres of this range site has been chained. The present plant community in the chained area is western wheatgrass, needlegrass, Indian ricegrass and crested wheatgrass with an overstory of big sagebrush, bitterbrush, rabbitbrush, small pinyon and small juniper. This site is presently producing approximately 650 lbs/acre of herbage annually.

Rocky Pinyon-Juniper

This range site is a woodland-shrub-grass complex on moderately steep to very steep hillsides with frequent sandstone and shale outcrops. The principal plant species are needle-and-thread, bluegrass, western wheatgrass, big sagebrush, bitterbrush, mountain mahogany and rabbitbrush. The overstory is pinyon and juniper. Vegetative ground cover is about 10 percent. Tree canopy cover is about 40 percent. The average annual production is 200 lbs/acre.

Approximately 300 acres of this site was also chained and has similar composition and production rates as the previously described chained mountain pinyon-juniper site.

Broadly Defined Soils

There is no single native plant community that can be identified for the vegetation on the broadly defined soils. The present vegetation consists of slender wheatgrass and Indian ricegrass with an overstory of fringed sagebrush, big sagebrush, greasewood, rabbitbrush and scattered pinyon-juniper. This area produces approximately 250 lbs/acre of herbage annually.

Threatened and Endangered Plants

A field survey of both C-18 and C-11 Tracts, for the occurrence of threatened, endangered or rare plants was conducted in May, 1982 by the Nature Conservancy under contract to the Bureau of Land Management. As a result of this inventory, three locations of *Astragalus lutosus*, dragon milkvetch, were discovered. *Astragalus lutosus* is a "candidate" species, Category 2 at the time of this writing. A Category 2 species is defined by the U.S. Fish and Wildlife Service as a "taxa for which information now in the possession of the Service indicates the probable appropriateness of listing, as endangered or threatened, but for which sufficient data is not presently available to biologically support a proposed rule." Specific locality data for the three populations of *Astragalus lutosus* are available upon request at the Bureau of Land Management in Meeker or the BLM District Office in Craig.

The habitat for *Astragalus lutosus* is that of a loose shale scree on steep to rolling slopes of the Green River Formation. Although *Astragalus lutosus* is rather common to the shale outcrops within the Piceance Basin of Colorado, in terms of national significance, it remains quite rare. No other threatened, endangered or rare plants are known to exist on the two tracts.

Grazing

There are approximately 150,000 AUMs on 139 grazing allotments within the White River Resource Area. The C-11 and C-18 Tracts lie mainly within the F and B pastures of the Square S Allotment, re-

spectively. At the present time, the allotment supports 1,000 cow/calf units from May 15 to December 15. This allotment is currently managed on a six pasture deferred rotation system.

Grazing capacity for public land on the allotment is 4,390 AUMs. Five hundred AUMs are available on each tract. The potential AUM production on the entire allotment is 6,600. The two tracts combined have the potential of producing 1,400 AUMs; 750 AUMs on Tract C-11 and 650 AUMs on Tract C-18. The potential for increasing AUMs on the C-11 and C-18 Tracts occur would be through manipulation of sagebrush overstory on the rolling loam range site. In order to achieve production potential, this allotment has been identified in the White River Management Framework Plan for revision of the grazing system and the proposed pinyon-juniper and sagebrush vegetation manipulations to increase grass production. Some of the sagebrush manipulations lie within the tract boundaries.

The existing rangeland projects in the B and F pastures that may be affected include one spring, one well with eight miles of water pipeline, and 1,500 acres of pinyon-juniper chaining. Not all of these projects are actually within the tract boundaries, but are located in areas where development could adversely impact these projects anyway (Figure III-12). On Tract C-11, one well with three miles of water pipeline and 700 acres of pinyon-juniper chaining exist. On Tract C-18, three miles of pipeline and 500 acres of pinyon-juniper chaining are present.

Forestry

Approximately 46 percent, or 2,300 acres, of Tract C-11 and approximately 50 percent, or 2,500 acres, of Tract C-18 is in pinyon-juniper woodland. Pinyon-juniper is the only forest type found on either tract.

The term woodland refers to an open forest of low, round-crowned trees, often bushy or contorted. The dominant species of the pinyon-juniper woodland in the Piceance Basin include Colorado Pinyon (*Pinus edulis*) and Utah Juniper (*Juniperus utahensis*). Tree densities and species composition vary considerably throughout both tracts.

Of all woodland acres on both tracts, only a small portion is considered commercially available, in terms of forest management. No large scale commercial activities or immediate plans for future sales are scheduled on these tracts. However, these tracts are open and managed for occasional individual use of firewood and fencepost cutting.

WILDLIFE

A total of 28 mammal, 66 bird, 5 reptile, and 1 amphibian species have been recorded or are speculated to inhabit the tracts either as residents or on a migratory basis. Since it is not feasible to address each species separately, only those species that may be significantly impacted or are of major concern will be discussed in detail below.

Terrestrial

Big Game

The Piceance Basin mule deer herd is considered to be the largest migratory herd in North America. Populations have fluctuated significantly since the 1950's (15,500 to 70,000) due mainly to severe winters, condition of winter range and habitat destruction. The herd population is presently increasing following a massive die-off during the winter of 1978 to 1979. Browse condition on winter range is generally poor, but has improved slightly over the last four years due to lowered deer populations and a corresponding reduction in winter forage use.

Both tracts are located in mule deer winter range. Ninety-three percent of C-11 and seven percent of C-18 are considered critical winter range by the Colorado Division of Wildlife (DOW). Critical range is key to herd sustenance during winters of unusually heavy and prolonged snow conditions when adjacent winter ranges are unavailable or inaccessible. A seasonal migration route traverses each tract. Figure III-13 indicates the location of ranges and migration routes.

Deer use of the tracts is almost exclusively during late fall, winter and early spring. Large numbers of deer arrive in October and increase in abundance through December as snow accumulations at higher elevations force deer descent to these lower winter ranges. Deer remain abundant on the area until early April and are essentially gone by May.

During winter months, deer seek chained pinyon-juniper and pinyon-juniper woodlands where preferred browse forage is most available. Beginning in March, deer make increasingly heavy use of succulent herbaceous growth in hay meadows and sagebrush bottomlands.

Deer abundance on the tracts varies annually depending on total herd size and winter intensity. During mild winters, deer prefer the use of off-tract

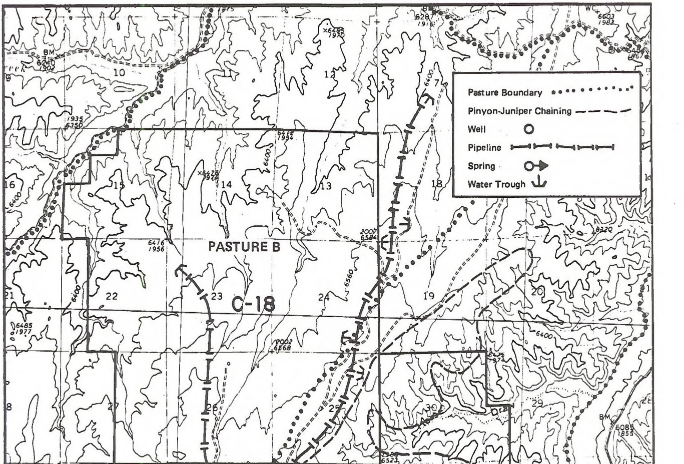
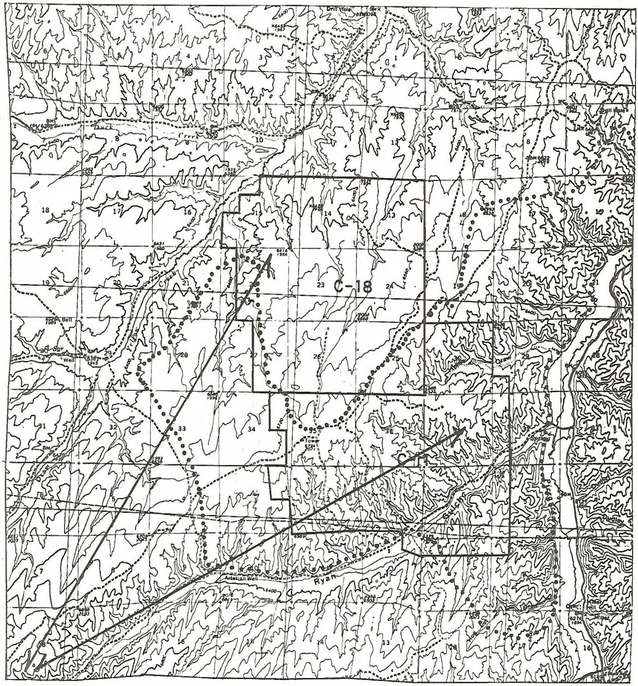


Figure III-12 Range Management Facilities

R. 98 W.

R. 97 W.



Note: Entire area is mountain lion winter range. Entire area outside critical winter range is mule deer winter range.

Figure III-13 Big Game Seasonal Ranges and Migration Routes

upper elevation pinyon-juniper winter ranges where greater browse production occurs. During harsh winters of sub-zero temperatures, windy conditions, and heavy snowfall, deer are forced to these lower elevation critical ranges where forage is more accessible on southern exposures with less snow accumulation.

BLM/DOW management objectives are to maintain a wintering population of 40,000 deer in Piceance Basin. This correlates to population densities of 54 and 80 deer per square mile on winter and critical winter ranges of the tracts, respectively.

Douglas et al (1981) calculated 1980 to 1981 winter range average densities on-tract to be 67 deer per square mile in the chained pinyon-juniper, 27 deer per square mile in the pinyon-juniper habitat, and 13 deer per square mile in sagebrush and greasewood-sagebrush bottom habitats.

Seasonal use areas for mountain lion coincide with those used by mule deer, their primary prey source. Average animal density for Piceance Basin winter range is four lions per 100 square miles. Elk occur on these tracts in low populations during winters of adverse weather conditions.

Raptors

One golden eagle nest on Tract C-18 has been active three times during the period 1975 to 1981. Two additional inactive cliff nests of poor condition (possibly red-tailed hawk) are located on each tract (Douglas et al 1981). Location of known raptor nests is available upon request from the BLM in Meeker. Although unknown at this time, it is highly probable that accipiters and owls nest in the pinyon-juniper woodlands on these tracts. Raptors commonly present in winter are golden eagles, red-tailed hawks, marsh hawks and rough-legged hawks.

Birds, Mammals, Reptiles, and Amphibians

Waterfowl seasonal use areas are associated with aquatic environments of perennial water along Piceance Creek and Yellow Creek. No known populations or potential habitat for migratory birds of high Federal interest occurs on these tracts. A list of other wildlife species known or expected to occur on the tracts with a brief, general description of each species habitat preference is available in the Piceance Basin Unit Resource Analysis - Step 2 and Douglas et al (1981).

Wild Horses

Approximately 20 to 30 wild horses reside in pastures B and F of the Square S Allotment. The objective of the White River Resource Area's Wild Horse Management Plan includes complete removal of horses from these two pastures by 1988.

Aquatic

The U.S. Fish and Wildlife Service (USFWS) and DOW have classified all streams within the affected area as limited game fisheries potential of low resource value. The White River downstream from Rio Blanco Lake is classified both as an endangered species fishery and as a limited game fishery.

These drainages are dominated by species from the Families *Catastomidae* (suckers) and *Cyprinidae* (minnows). Very few game fish species are present, except in the upstream portions of the White River, Piceance Creek and its major tributaries (Black Sulphur, Fawn, Willow and Stewart Creeks).

No major stream/pond aquatic habitats occur on Tracts C-11 or C-18.

Threatened and Endangered Species

Six species were presented in the list received from USFWS for analysis in the biological assessment. It was determined that no populations or suitable habitat for black-footed ferret, whooping crane and peregrine falcon are present within the tract areas.

Bald eagles reside in the White River valley from October through March as winter residents and migrants. Core populations in winter vary from 50 to 70 birds, with migratory peaks of up to 160 birds in March. Bald eagles roost in cottonwood stands and Douglas fir stands along the White River and forage in upland areas. Foraging eagles are evident throughout Piceance Basin during the winter months, but no high use or preferred areas has been defined.

It has been regularly documented that Colorado River squawfish occur in the White River. The Colorado segment of the White River is considered habitat for juvenile and adult squawfish. Apparent importance of the White River to endemic fish in the Upper Colorado River Basin is quantity and periodicity of water flow.

There is one report of a humpback chub from the White River (Sigler and Miller 1963). However, the Colorado River Fishes Investigation Team, established in April 1979, have not found recent evidence of this species inhabiting the White River.

CULTURAL RESOURCES

Tract C-11

Sixty-six percent of Tract C-11 has been surveyed at the Class III inventory level for cultural resources. This survey, which was performed by the Laboratory of Public Archaeology (Weber et al April 1977), covered approximately 3,350 acres. Sixteen sites and 13 isolated finds were recorded. Of these sites, none are presently listed on the National Register of Historic Places, four are considered eligible, one may be eligible, ten are not eligible, and the eligibility status of one site is unknown. Based on data from the area which has been surveyed to date, the ratio of known cultural resources per acre inventoried for Tract C-11 is 1:116. This is considered moderate when compared with data from other areas within the White River Resource Area.

Tract C-18

Thirty-nine percent of Tract C-18 has been inventoried for cultural resources. Of a total of approximately 1,980 acres, 1,880 were inventoried by Grand River Institute (Conner and Langdon January 1981) and 100 acres were inventoried by miscellaneous contractors for the permitting of several wells and access roads. A total of 18 sites and 15 isolated finds have been recorded within the tract boundary of these sites; the Duck Creek Wickiup Village (5RB53) is listed on the National Register of Historic Places, three are considered eligible, two may be eligible, three need more data before eligibility can be assessed, five are not eligible, and the eligibility status of one site is not known. The ratio of known cultural resources per acre inventoried for Tract C-18 is 1:60. This would indicate that there are a greater number of potential cultural sites to be encountered on Tract C-18 than on C-11 even though less area has been inventoried. A 100 percent Class III pedestrian survey (Environmental Stipulations of the lease, Section 6), conducted prior to any surface disturbance as a result of the proposed action, could verify this.

Predictive Model

The consulting firm of Gilbert/Commonwealth is currently under contract to the Bureau of Land Management for a cultural resource study in the Piceance Basin including the proposed lease tracts. The general purpose of this study is to generate cultural resource data of area-wide suitability for planning for projected oil shale development. Specific objectives include:

1. Recognition or elaboration of patterns of past human use and occupation;
2. Development of projections of expected density, distribution, and diversity of cultural resources;
3. Identification and assessment of the environmental and/or cultural variables or combination of variables that form the most accurate predictors of cultural resource sites;
4. Determination of research direction for the study areas that will provide guidance for future research and a basis for formulating and evaluating mitigation plans (Newkirk et al March 1982).

This study, due to be completed by October 1, 1982, will provide a predictive model which can be used to determine the likelihood of encountering cultural resources on a site-by-site basis. If the model generated predicts site locations within a statistically acceptable range, it will be used in future land use actions.

PALEONTOLOGY

Four geological units outcrop on Tracts C-11 and C-18. The oldest is the Thirteen Mile Creek tongue of the Green River Formation over which lay tongues 4 and 5 of the Uinta Formation (Duncan 1976). In addition to that, Pleistocene or Recent alluvium is found along some creek bottoms. These units are described in greater detail in the Geology section of this chapter.

These units are important for vertebrate and invertebrate fossils for several reasons. The Green River Formation is well known for its well preserved fish and insect fossils. The fish fossils are of special interest here because the Green River Formation in the Piceance Basin is slightly younger than it is in the better known fish fossil localities in Wyoming, and would be valuable in understanding the evolution of certain Eocene fish. These fish fossils may be encountered while sinking a shaft or while

drifting, or crosscutting, at depth. They are not likely to occur at the surface on these two tracts. The size of these fish fossils ranges from less than one inch to several feet, although the smaller ones (less than one inch to about four inches) are more common.

The insect fossils of the Green River Formation are abundant but unique in that usually they are very well preserved. The size of these insect fossils are comparable to present day insects such as flies, ants, bees, larvae etc., and would be hard (if not impossible) to see from the top of earth moving equipment. Fish fossils would similarily be difficult to see. The Green River Formation also has an abundance of plant fossils such as leaf fragments which are of minor significance.

Tongues 4 and 5 of the Uinta Formation also contain both vetebrate and invertebrate fossils. Tongue 5 covers the majority of the surface area within Tracts C-11 and C-18. In this unit most of the vertebrate fossils are medium to large in size, representing relatives of the horse, rhinoceros and tapir, however smaller mammals (such as mongoose-like mammals) are also represented by jaws and teeth or parts thereof.

The insects and plant fossils found in tongues 4 and 5 of the Uinta Formation are significant in that late Eocene plant fossils are rare, and late Eocene insect fossil localities were unknown in the United States before 1978. These fossils seem to be concentrated in lenses of mudball conglomerates. Research or exhibit quality vertebrate fossils can be found at about every 400 to 500 yards of outcrop.

No detailed study of the fossil vertebrates of the Piceance Basin exists, however, references to these fossils can be found in several publications, making them time consuming and difficult to locate and reference. One of the objectives of the paleontological inventory and survey currently being performed in the Piceance Basin is to consolidate these scattered references together in a useful volume. That information will be available in October 1982.

A paleontological resources inventory and evaluation was done by Dr. Peter Robinson in 1978 for the Horse Draw Bureau of Mines Project which covers the northeastern part of Tract C-11. This survey revealed two Brontothere skulls, which were not collected, along with several limb bones, teeth and assorted bone fragments. A bison skull and isolated tapiroid teeth were also found. Many plant fossils, some of which were rare late Eocene plants, were collected along with one late Eocene insect larvae. A detailed list of the fossils found, their quality, location and importance can be found in the referenced survey. A good quality miacidae jaw was found less than two miles from the northwest corner of Tract C-18. It is expected that fossils of similar quality and importance might be found throughout Tracts C-11 and C-18.

VISUAL RESOURCES

In 1978, the White River Resource Area was inventoried for an evaluation of its visual resources. The evaluation consisted of a three step assessment of 1) the visual quality of the landscape, 2) the sensitivity of the area with regard to the number of viewers, and 3) the distance that the viewed area is seen from major transportation routes.

Scenic quality is perhaps best described as the overall impression retained after driving or walking through an area. Each area is rated by seven key factors: land form, vegetation, water, color, influence of adjacent scenery, scarcity and cultural modification. The values for each category are calculated and, according to total points, three scenic quality classes are determined and mapped:

Class A - Areas that combine the most outstanding characteristics of each rating factor (19 - 33 points).

Class B - Areas in which there is a combination of some outstanding features and some that are fairly common to the physiographic region (12-18 points).

Class C - Areas in which the features are fairly common to the physiographic region (0-11 points).

Sensitivity was determined by use volume. Frequency of travel through an area and the local use of that area was tabulated. The area was then assigned a high, moderate or low rating according to predetermined classifications.

Related to the sensitivity rating is the distance zone. The visual quality and the sensitivity of a landscape may be magnified or diminished by the visibility of the landscape from major viewing routes. Major routes are B Class County Roads or better. The only major route near the tracts is County Road 5, Piceance Creek Road. It is located approximately one-half mile from the eastern boundary of Tract C-11 and one and a quarter miles from the eastern boundary of Tract C-18. This would place most of the project development on lands which cannot be seen from Piceance Creek Road.

All of Tract C-18 and most of Tract C-11, except for Ryan Gulch, (see Figure III-14) are rated as "C" Quality. This area is characterized by rolling to oc-

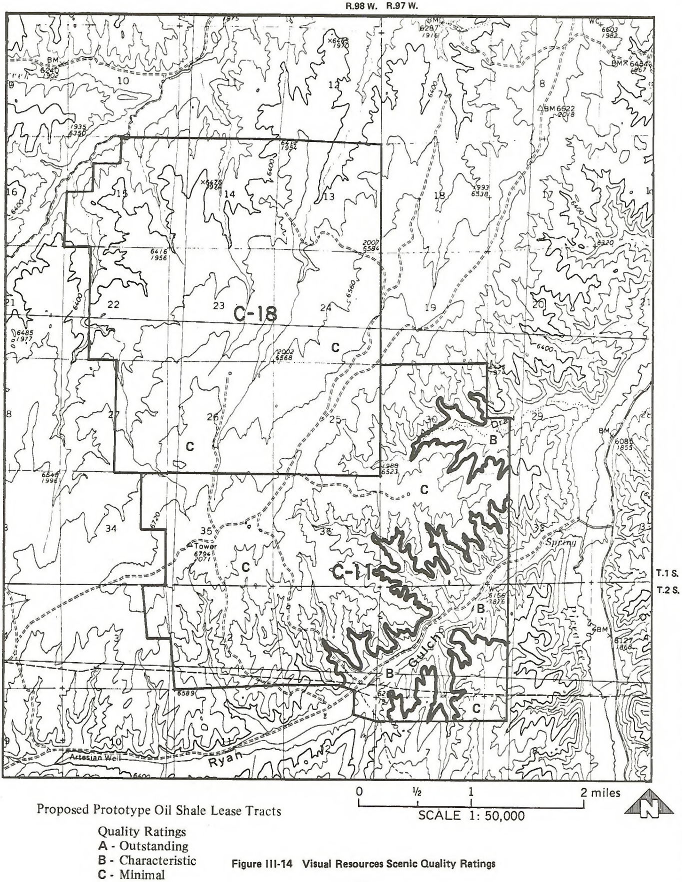


Figure III-14 Visual Resources Scenic Quality Ratings

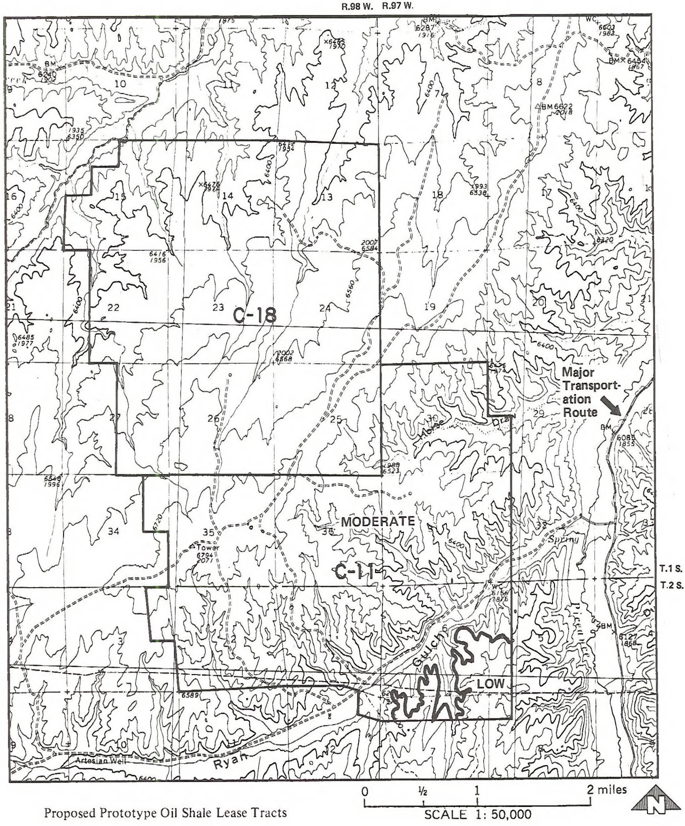


Figure III-15 Visual Resources Sensitivity Zones

casionally steep hills. Numerous sandstone rock outcrops occur within the landscape but generally do not create much interest due to their small scale. Vegetation is dominanted by relatively dense stands of pinyon-juniper. Sagebrush and mountain brush species also exist to a large degree in the area. Out of a total possible score of 33 this area is rated 9.

The Ryan Gulch area is rated as "B" Quality. This area is characterized by the meandering Ryan Creek floodplain. Vegetation consists primarily of grasses and sagebrush. Out of a possible score of 33 the area is rated 12.

All of Tract C-18 and most of C-11 is rated as having moderate sensitivity. The southeastern corner of C-11 is rated as low sensitivity (see Figure III-15).

RECREATION

The current (1979 to 1980) recreation use of the area is predominantly hunting. Big game hunting use is indicated by big game hunting unit 22; a 1,038 square mile area, located between Cathedral Bluffs to the west, Highway 13/789 to the east, Highway 64 to the north and the Roan Cliffs to the south. The proposed tracts are located near the center of this unit. Small game hunting use is measured by small game hunting unit 22, a 1,930 square mile area, located between the Utah State line to the west, Highway 13/789 to the east, Highway 64 to the north and Roan Cliffs to the south. The proposed tracts are located near the east/central portion of this unit.

Mule deer and elk hunting dominate the big game sports. For deer hunting in 1980, 1,197 residents of Colorado and 2,147 out-of-state hunters utilized unit 22 for a total of 13,060 recreation days. A recreation day is any portion of a 24 hour day used for recreational purposes by one person.

Total big game hunting use for this unit, to include bear and lion, for 1980 was 4,385 hunters using 17,634 recreation days. Deer season ran from August 30 to November 5. Elk season ran from August 30 to November 11.

Rabbit hunting dominates the small game hunting sports. In 1979, 1,065 hunters used the area for hunting rabbits and hares for a total of 3,774 recreation days. Total small game hunting, to include waterfowl, included 1,844 hunters using 10,751 recreation days.

Hunting use trends in the Piceance Wildlife Unit are on the upswing. Animal populations are recovering from previous declines due to winter kills. Based on animal management projections (see Chapter III, Wildlife) recreation use will likely increase 50 to 60 percent over the next two to three years then level out to a steady five to seven percent increase annually, if existing conditions persist.

WILDERNESS

In November 1980, an intensive wilderness inventory was completed for the White River Resource Area. No Wilderness Study Areas were identified in the Piceance Basin Planning Unit.

In addition, no designated Wilderness Areas are located in the Resource Area. The nearest designated Wilderness Area is the Flat Tops, located in White River National Forest, 40 miles to the east. The nearest administratively approved Wilderness Study Area is Dinosaur National Monument, located 36 miles to the north (see Figure III-1).

SOCIAL

Seven towns would be affected by the proposed development: Glenwood Springs, Rifle, Silt, Parachute, Grand Junction, Rangely and Meeker. Of these, Parachute and Grand Junction would not be significantly affected.

Silt

Silt grew from 380 to more than 1,000 persons between 1970 and the summer of 1981, (most of it since 1980) because it provided lower cost housing for service workers in tourist areas to its north and east, and to oil shale projects in the Parachute-DeBeque area to the west. Silt may be shifting from an independent small town, within the shopping district of Glenwood, to a bedroom community serving both Glenwood and Rifle. Officials in Silt have tapped oil shale trust funds to improve the town's facilities because they expect the population will reach 3,500 within a few years.

Typical of rapid growth, political and service structures have become more formal. Law enforcement, in 1970 composed of only a town marshall, now consists of a full-time and a part-time deputy, and three reserve officers on call. A rise in crime seems to be general. One minister reported a rise in marital counseling, generated in part by the

stress that comes when newcomers do not easily find jobs in the area.

Glenwood Springs

Glenwood Springs, (pop. 6,000) is primarily oriented toward tourism -- skiing, the famous hot springs bathing, and other outdoor sports. Its geographical location in a narrow scenic canyon and its refusal some years ago to permit a highway bypass causes downtown congestion and noise. New growth is confined to the Roaring Fork valley southward, and Colorado River valley westward.

The hiring of professional planners is strong evidence that local government decision making processes are becoming more formal. This has brought some conflict between longtime town leaders and those newer to the area who more readily accept the new expertise.

Because of its desirable location, Glenwood has many health practitioners. The regional hospital has a high use rate which may mean new facilities will be needed in a few years.

The entire county is served by a very active mental health regional center with branches in surrounding communities. In recent years, the services have greatly expanded, as needs have continued to grow. Mental health officials report case load increases. The center is also developing prevention programs in the region.

Law enforcement has expanded and become more formal and professional, although low salaries make it difficult to hold trained personnel. There is an alcohol treatment facility in the town. Police officials estimate that the influx of energy workers has brought no problems beyond their proportion in the population.

The public schools have somewhat declining enrollments, an anomaly in view of the growth. Increases in discipline problems have brought about formation of a Parent Advisory Committee to help find solutions. A high student turnover rate (20 to 30 percent in and out during the year) has brought some problems.

Among the outstanding changes in the social structure has been the growth of the Colorado Mountain College program. Headquartered in Glenwood, it serves several counties through its branches. It provides a highly innovative junior college program tailored to the needs of the area, plus some upper division and graduate courses in cooperation with other state colleges. The college has seen very strong growth from 4,355 to more than 25,000 in the years 1969-70 to 1979-80. In addition to academic and trade/technical courses, the college has also developed training in human services delivery and engaged in these services directly -- counseling and communications, senior citizen transportation and nutrition, a community resource center in Rifle, a consortium for human services education, and programs directly related to western slope energy development. The county government in in Glenwood Springs is rapidly formalizing.

Rifle

Rifle was at the center of an "oil shale boom" at least twice before the present -- in 1913 and again in the late 1940's, though in each instance the boom was more in expectations than in reality. The skepticism growing from those times made the community doubtful that oil shale would "go" in the 1970's and 1980's. Only recently did skepticism give way to belief -- just in time to be shattered by the slow-down of oil shale development in the region.

Rifle has prepared for growth by various funding methods. Boom conditions have existed since the late seventies as population increases began producing shortages and congestion as well as some better shopping facilities, expansion and improvement of social services delivery systems such as mental health, a newcomer integration project, a branch of Colorado Mountain College, and programs for the elderly. A $100 million Human Services building is being planned for Rifle, in which space would be free to services providers.

Other responses to structual pressures have also occurred. Efforts to control downtown congestion on Railroad Avenue (Hwy. 13 north-south) has caused some citizen/local government conflicts because of disagreements regarding a by-pass route. In the most recent local election (late 1981), three of five new council members were new residents, evidence that the political base is diversifying in Rifle. Rifle has more than tripled its population since 1972.

According to a recent BLM (1981) study based on a random sample of 109 persons, the people of Rifle favor energy development by a two-thirds majority, but not at the expense of a deteriorating environment. Oldtimers feel the stresses of seeing their community become more congested and less psychologically comfortable, but in general they also see some advantages such as better employment opportunities for the younger population. They are glad for better shopping facilities, and they believe the country needs the oil. Respondents in this study saw the biggest problems as rise in living

costs, traffic congestion, higher crime rates, and housing shortages. Fifteen percent were concerned about the natural environment.

Twenty-nine percent of the respondents felt that local communities have no influence on whether energy production occurs in the area, 41 percent felt they had very little influence, 13 percent said some, and 17 percent said a lot. In-depth interviews with 22 of the respondents revealed, however, that some persons do not believe the local community should have much influence in such decisions. The most common view expressed was that a community should not be able to stop development, but that it should be able to impose mitigative restrictions on the companies.

Of things liked most about living in Rifle, respondents most often mentioned friendliness of the people, natural beauty of the area, climate, outdoor recreation, and small size of the town (23 percent). Those holding energy jobs and newcomers were less likely to mention friendliness of the people. Newcomers often felt that they were not warmly received by the town, and that oldtimers were too suspicious of them.

In-depth interviewees ranked wildlife as of highest priority, with watershed second. The other four choices (range, timber, recreation, and energy and minerals) were of about equal rank.

Meeker

Meeker traditionally was a scenically located small, isolated ranching community with a hunting-fishing tourist trade in fall and summer. But it, like Rifle, has lived in the shadow of energy development for 80 years. Only since 1975 has the activity seemed certain enough to erode the skepticism of lost expectations from the past.

By about 1980, a general spirit of either resignation to, or active acceptance of, energy growth was beginning to prevail. Local and county governments were developing a more formal structure to provide for growth management. Professional planners were hired, oil shale trust fund and other impact monies were obtained, and an advisory group of local leaders, business, government, industry and human service representatives was formed. A Human Resources Council was started to draw together coordinative planning, and identify needs. A recreation survey and plan were developed.

Additional housing of various price ranges was built at a rapid pace; social services, such as mental health, aid for the handicapped, and a branch of Colorado Northwest Community College, were all being added or expanded. Some conflicts among various interest groups and some competition for funding have of course been inevitable.

The "boom" conditions which bring about social changes with their individual social-psychological stresses have now slowed in Meeker. Leaders now have concern for surplus housing, unemployment, etc.

A 1981-82 on-going study of social impacts upon Meeker (Growth Impact Group 1982) indicates that the people of Meeker continue to treasure their beautiful natural environment with its clean air and clean water.

A 1975 study of 350 Meeker residents showed that while they generally considered growth to be inevitable, 18 percent preferred no growth at all, while 60 percent preferred growth to 3,000 to 5,000, only five percent wanted Meeker to grow to more than 10,000. Significantly, 51 percent favored the establishment of a new town close to the mine sites of Piceance Basin.

One local conflict of importance is between the community and an out-of-state development organization, the Bar 70 Enterprises, which seeks to build up to 5,000 new housing units for some 20,000 persons over the next 20 years, on a large tract on the east side. The local newspaper provides a running account of the conflicts, and apparently the general fear is that such a large development would totally change the character of the town, and "what would that many people do here?"

Thus Meeker has been in a boom growth pattern for several years but is currently in a slump. If the slump ends within a reasonable time -- say one to two years -- it is probable that its occurrence will give the community the breathing spell necessary to catch up sociologically with the changes that have occurred.

Rangely

Rangely is more isolated, less scenic, more arid, and has a very different historical setting than Meeker. Distance from other Colorado towns has caused it to orient more to the Vernal, Utah area, a tie made more firm recently by the Western Fuels Coal operation a few miles east of town. Coal is to be taken by electric railroad to the Deseret Generating plant near Bonanza, Utah.

The drier climate supports less ranching and little tourism.

Rangely's population jumped from 100 or so to 5,000 during the oil and gas boom of World War II. Rangely is thus a younger town than Meeker, has

always been an energy town, and its traditions did not grow out of the usual ranching society of northwest Colorado. The town has always struggled to retain its population, and both prepared for and welcomed energy development during the late 1970's when energy independence became a national priority.

Among Rangely's preparations for growth was a Recreation District that obtained financing for the most complete recreation facility in the region Colorado Northwest Community College has put together a technical program geared specifically to energy production; the hospital and schools have low occupancy rates so can absorb considerable growth; planning, zoning, and stipulations on Western Fuels for front-end financing, have made possible further social and economic impact mitigations. Housing has continued to be in short supply, but recent purchases of land from BLM will make possible further expansion of the community.

Practical and political problems over building a good road to Rangely from C-a Tract continue to obstruct additional population from oil shale operations in Piceance Basin, and a similar lack of a good road limits the numbers of Deseret Power Plant workers who might otherwise live there rather than in Jensen or Vernal.

Rangely has shared with Meeker the establishment of the county-wide Advisory Group and the Human Resources Council. Some services formerly based in the county seat of Meeker now have branches in Rangely (for instance, the Mental Health Clinic). The two communities share law enforcement also.

The slump which has affected Meeker and Rifle has not been a big factor in Rangely because it had fewer workers in oil shale, and also because of the influx of workers for the Western Fuels mine.

No up-to-date attitude studies are available for Rangely, but there probably now exists some concern about rapid growth, a shift from the highly positive orientations and preparations which prevailed until very recently.

A discussion of social impact processes and their causes is presented in Chapter IV. From it, the existing "boom" situation described here for the seven communities can be delineated and evaluated for on-going impacts from the alternatives.

ECONOMICS

Impacted Area

Economic data is available only by county. Therefore, an impacted area for economic analysis has to be defined in terms of whole counties. The impacted area for this analysis consists of Garfield, Mesa, and Rio Blanco Counties. Although the proposed tracts are located in Rio Blanco County, a majority of the work force in neighboring prototype Tracts C-a and C-b lives in Garfield County, and it is likely that this pattern will continue. Grand Junction, in Mesa County, is the regional business and retail center and receives a large portion of the secondary impacts from oil shale and other projects. Because the southward patterns of commuting and purchasing are expected to continue, little impact is projected for adjacent Moffat County to the north and Uintah County, Utah to the west.

Employment and Income

Employment and income figures from 1980 are shown in Table III-10. The construction and mining industries are listed separately because these are where the primary impacts would occur. Secondary impacts would be scattered over a number of other industries.

The figures in Table III-10 are by place of residence. For this reason they will differ from most other employment and income figures, which are by place of work and do not take commuting into account.

Both Garfield and Mesa Counties have diversified economies. Garfield county has an important tourist trade. Mesa County is a business and manufacturing center and has a large agricultural sector. Rio Blanco County, in contrast, has a major part of this present economy based on mineral development. Livestock production remains an important factor in all three counties, but has become small numerically compared to the other developments. Rio Blanco County also has a tourist trade, dominated by fall hunting and summer mountain recreation.

Population

Table III-11 shows 1980 populations.

Mention needs to be made of Census county divisions. In cooperation with local officials, the

TABLE III-10
1980 EMPLOYMENT AND INCOME

	Number	Percent of Total
Garfield County		
Total Employment	11,340	100.0
Construction	1,241	10.9
Mining	693	6.1
All Other	9,406	83.0
Total Labor Income (000)	$145,886	
Mesa County		
Total Employment	36,607	100.0
Construction	2,733	7.5
Mining	2,121	5.8
All Other	31,753	86.7
Total Labor Income (000)	$492,875	
Rio Blanco County		
Total Employment	4,789	100.0
Construction	1,097	22.9
Mining	1,563	32.6
All Other	2,129	44.5
Total Labor Income (000)	$91,714	

Source: BLM estimates derived from:
Colorado Division of Employment and Training. Colorado Manpower Review.
US Bureau of Economic Analysis. Regional Economic Information System.

TABLE III-11
1980 POPULATION

	County	Census County Division	Community
Garfield County	22,514		
Glenwood Springs Division		12,394	
Carbondale			2,084
Glenwood Springs			4,637
Grand Valley Division		956	
Parachute			338
New Castle Division		3,943	
New Castle			563
Silt			923
Rifle Division		5,221	
Rifle			3,215
Mesa County	81,530		
Clifton Division		13,682	
Palisade			1,551
Grand Junction Division *		54,222	
Grand Junction *			28,144
Other Divisions *		13,626	
Rio Blanco County	6,255		
Meeker Division		3,642	
Meeker			2,356
Rangely Division		2,613	
Rangely			2,113

* Ten persons in Grand Junction live in the Fruita Division, but are shown here in the Grand Junction Division

Source: Colorado Division of Planning. <u>1980 Census Report Number 2</u>.

Census Bureau divides most counties into two or more parts. Maps of the county divisions can be found in Population Census reports. In the impacted area, most of which is sparsely populated, the great majority of a county divisions population is located in or adjacent to its communities. For this reason, and because city boundaries can readily be changed, it is believed that county divisions make a better base for projects than present city limits. Therefore, all projections will be for county divisions and should be compared to the 1980 division populations.

Because Grand Junction has a metropolitan-type development, the Clifton and Grand Junction Divisions are used to represent that area.

Uneven population distribution characterizes the impacted area. The majority is located in the Grand Junction area of Mesa County. Garfield County's population is heavily concentrated in the central and eastern parts of the county. Settlement in Rio Blanco County is clustered around its two communities. Areas between these population modes consist of sparsely settled ranching country and unpopulated national forest.

Recent rapid growth has occurred in most of the population centers, for differing economic reasons as described in the section on employment. Grand Junction is the regional business and supply center and is experiencing a continuing growth in energy industry administrative officers. Carbondale and Glenwood Springs in eastern Garfield County are tourist oriented, with growth occuring in both summer and winter activities and in recreation home development. The four communities in the center of Garfield County are presently being impacted by oil shale projects (and will probably continue to be). Meeker's growth rate has slackened because of slow downs in local coal and oil shale projects, but Rangely is experiencing a continued growth from conventional oil and gas development. Except in the Grand Junction area, all of these communities are small and thus, are highly subject to the impacts of large scale projects.

A commuting pattern has been established in which workers at the oil shale projects in Rio Blanco County reside primarily in the central Garfield County communities, particularly Rifle. Company busing is a main reason for this pattern, along with the limited retail and service facilities in Rio Blanco County.

Housing

Housing data from the 1980 Census is shown in Table III-12.

Vacancy levels indicated in the table may not be very meaningful. Current growth is putting pressure on the housing supply in most of the communities, especially those in central Garfield County. Considerable new housing has been built since 1980 in those communities as well as the Glenwood Springs-Carbondale and Grand Junction areas. Also, housing vacancies will include a number of older units in poor condition that are not suitable to include in the future housing supply.

Other Impacted Industries

Agriculture

Livestock production is the principal agricultural activity in Garfield and Rio Blanco Counties. Crop production is dominated by hay for livestock use. Available statistics do not show earnings from livestock production. Preliminary 1980 figures on earnings from crop production are $6,060,500 in Garfield County and $2,906,500 in Rio Blanco County.

Mesa county has an important fruit growing industry in addition to livestock production and hay. Crop production earnings in 1980 totaled $22,333,000, about one-fourth of which came from vegetables.

Irrigation is important to agriculture in the regions dry climate, but more so in Garfield and Mesa Counties than in Rio Blanco County. Slightly over one-half of Rio Blanco County's harvested acreage in 1980 was irrigated, mostly hay. Some pasture is also irrigated, but the amount is not recorded.

Recreation

Hunting is the only significant recreation activity on the proposed tracts. In 1979, an estimated total of 126,300 days were spent by hunters in Rio Blanco County. At an average of $6.62 per day in 1980 dollars (derived form an input-output model of northwest Colorado), the economic value to the county was about $840,000. Hunting of deer, the most economically important game animal, contributed some of $440,000, or 52 percent of the total.

Local Government Finances

Area communities obtain most of their revenues locally. As shown in Table III-13, local sources account for 67 to 95 percent of total community revenues. These figures appear high for two reasons: (1) they include enterprise funds, which are primar-

TABLE III-12
1980 HOUSING UNITS

	Occupied	Vacant
Garfield County	8,131	1,214
Carbondale	724	106
Glenwood Springs	1,930	230
New Castle	233	22
Parachute	129	15
Rifle	1,170	200
Silt	331	26
Unincorporated	3,614	615
Mesa County	29,668	2,905
Grand Junction	11,766	940
Palisade	585	72
Other & Unincorporated	17,317	1,893
Rio Blanco County	2,104	420
Meeker	846	135
Rangely	684	59
Unincorporated	574	226

Source: Colorado Division of Planning. 1980 Census Report Number 2

TABLE III-13
1980 COMMUNITY REVENUE SOURCES

	Carbondale	Glenwood Springs	New Castle	Parachute	Rifle	Silt	Grand Junction	Meeker	Rangely
Source of Revenue (%)									
Local 1/	92	95	75	87	87 3/	75	93	67	73
State 1/	5	3	23	11	3 3/	20	4	30	23
Federal 1/	3	2	2	2	10 3/	5	3	3	4
Assessed valuation									
Total (000)	$6,208	$21,567	$915	$538	$9,555	$1,373	$121,928	$6,422	$5,383
Per capita	2,979	4,651	1,625	1,592	2,972	1,488	4,332	2,726	2,548
Total mill levy	7.80	6.86	10.44	13.91	10.49	18.89	12.00	8.506	26,32
Retail Sales									
Total (000)	$15,908	$149,171	NA	NA	$48,230	NA	$670,252	$16,835	$38,172
Per capita	7,633	32,170	NA	NA	15,002	NA	23,815	7,146	18,065
Sales Tax Rate (%)	3.0	2.0	2.0	2.0	2.0	3.0	2.0	1.0	1.0
Bonded indebt. (000) 1/									
General obligation	$81	$2,070	$180	$0	$981 3/	$71	$5,800	$0	$221
Revenue	1,397	415	0	0	18 3/	0	8,655	1,347	666
Remaining bonding capacity (000) 2/	540	4/	0	54	4/	66	4/	642	317

NA: Not Available
1/ Figures include enterprise funds (water and sewer service, etc. but exclude large one-time federal and state grants.
2/ 30% of actual valuation (at 30% assessment rate equals 10% of assissed valuation) less general obligation bonds outstanding.
3/ 1979 data
4/ Home rule cities are exempt from bonding limit.

Source: Colorado Division of Local Government, 1980 Local Government Financial Compendium. Colorado Division of Property Taxation, Tenth Annual Report, 1980. University of Colorado, Business Research Division. Colorado City Retail Sales by Standard Industrial Classification, Calender Year, 1980. Colorado Department of Revenue, Annual Report, 1981.

ily funded by local charges, and (2) they exclude large state and federal grants, which are one-time items and not part of the normal budgets. This large dependence on local sources means that the communities can be highly impacted by developments that affect their tax base.

Rough measures of local funding sources are provided by per capita figures on assessed valuation and retail sales. They show that, in general, the larger communities have more susbstantial property tax bases, but that sales tax bases vary according to individual circumstances. The latter aspect is important because sales taxes make up from 18 to 48 percent of total community revenue (except in New Castle, which does not have one), with a median figure of 26 percent. Those communities having strong retail sales bases, generally because they are either business or tourist centers, will be in a better position to handle the financial impacts of growth.

At present, the communities ability to increase these revenue sources is restricted. State law imposes a seven percent limit on annual increases in property tax revenues, and a four percent ceiling on combined municipal and county sales tax rates. Since only Rio Blanco County presently has a sales tax two of the communities have some leeway to raise revenues by that means.

Figures on remaining bonding capacity in Table III-13 show how much major capital improvement could be funded from local resources. State law imposes the ceiling shown in footnote 2 of the table on community general obligation debt, except for home rule cities. With a couple of exceptions, the communities have more than half of their bonding capacity still available for use. However, rapid growth frequently imposes captial requirements in excess of most communities local resources. Although state and federal assistance is often available for these needs, it is seldom enough to meet all requirements and involves the uncertainity inherent in seeking loan and grant awards.

TRANSPORTATION

Three types of transportation facilities are addressed in this EIS: highways, railroads and pipelines.

Highways

Major highways and county roads, which service the general area of the tracts, are Colorado 13/789 which runs from Rifle north to Meeker, Craig, and Wyoming; Colorado 64 which runs from Dinosaur to Meeker through Rangely; and Rio Blanco County Road 5 which forms a loop between Colorado 13/789 and Colorado 64, also known as Piceance Creek Road.

The affected highways are Colorado 13/789, between Rifle and Meeker; Colorado 64, between Rangely and Meeker; and Rio Blanco County Road 5. Figure III-16 shows the location of these highway segments. Highway use for these segments is currently well under capacity. Highway use, capacity, and accident statistics are given in Table III-14. Colorado 13/789 receives the most use, and also has the largest number of accidents.

Capacities for state highways are figured with traffic able to average about 50 miles per hour, and 40 miles per hour for county roads.

Peak hour traffic is the 30th highest amount of traffic that can be expected in an hour for the year. It approximates the above average rush hour traffic. The peak hour traffic/capacity ratio indicates approximate traffic conditions on the highway during high use. If this ratio is near 85 percent, momentary slowdowns in traffic will occur. If this ratio is near or over 100 percent, general traffic speed would be reduced to 40 miles per hour on state highways and 30 miles per hour on County Road 5. As can be seen in Table III-14, the volume of traffic on any given segment would have to increase greatly for any traffic congestion to occur.

An undetermined amount of pavement damage presently occurs on these highway segments, but there is no large scale trucking of any minerals to a railhead or pipeline terminal.

Planned improvements to local highways include the construction of a 22 mile gravel surfaced county road between the C-a Tract and Rangely and a by-pass on Colorado 13/789 to be built around Rifle.

Pipelines

There are presently no shale oil pipelines in the area. For shale oil to be transported with crude oil in crude oil pipelines it must first be "sweetened" by removing sulfur and arsenic along with other impurities. There are several crude oil pipelines in the area. An Amoco pipeline laid in 1947 between Salt Lake City and Casper, Wyoming passes within 35 miles of the tracts to the north near US Highway 40. This pipeline has a capacity of about 60,000 barrels per day.

TABLE III-14
AFFECTED HIGHWAY SEGMENTS (1980)

Segment Letter	Description From/To	Segment Length (miles)	Daily Traffic	Peak Hour Traffic (PHT)	Highway Capacity at 50 mph	PHT/ Capacity rate (%)	Total Accidents per year	Fatal Accidents per 10 years
A 2/	Colorado 13 from Rifle to Rio Blanco	19.3	1,800	252	865	29	55	3
B1 3/	Southern half of Rio Blanco County Rd 5	19.0	300	40	850 1/	5	8	1
B2 3/	Northern half of Rio Blanco County Rd 5	20.0	200	30	850 1/	4	6	1
C 2/	Colorado Highway 13 From Meeker to Rio Blanco	22.3	1,680	235	875	27	44	4
D 2/	Colorado Highway 64 From Meeker to County Road 5	17.1	740	104	820	13	18	2
E 2/	Colorado Highway 64 From Rangely To County Road 5	36.5	630	88	820	11	24	3

1/ Highway capacity at 40 rather than 50 miles per hour due to lower design standards.

2/ Source: Colorado State Department of Highways.

3/ Source: Cathedral Bluffs Shale Oil Company

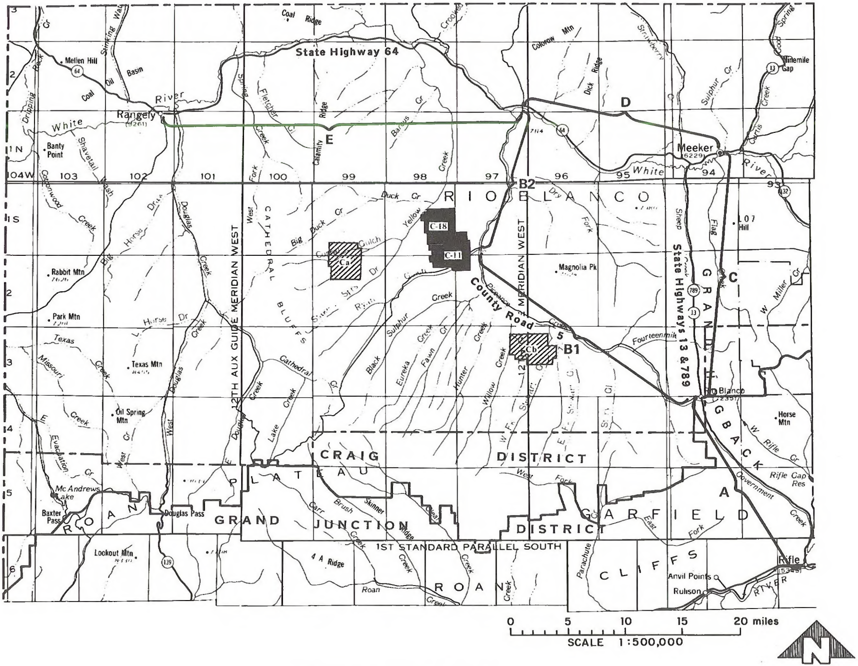


Figure III-16 Affected Road Segments

A six inch Wesco pipeline built in the early 1950's runs between Bonanza, Utah and Loma, Colorado near Grand Junction. Approximately 4,000 barrels per day pass through this pipeline. Due to the age and small capacity of these pipelines, a large pipeline with a high capacity, suited to transporting shale oil would need to be built if any large scale production of oil shale began.

The La Sal Pipeline Company has proposed a pipeline to run from Exxon's Colony Oil Shale project near Parachute, Colorado to Casper, Wyoming. The pipeline would be 16 inches in diameter with a capacity of up to 150,000 barrels per day. While there are no firm plans for construction at this time, this pipeline or one similar would provide much of the needed capacity to transport shale oil out of Piceance Basin. One of the proposed laterals to the La Sal pipeline would cross the northern portion of Tract C-11 and the central portion of Tract C-18.

Railroads

Two railheads are in this region. One is located south of Craig, Colorado, the other at Rifle, Colorado. Both are serviced by the Denver and Rio Grande Western Railroad, which services the area between Denver, Colorado and Salt Lake City, Utah. A rail system into Piceance Basin has been studied and evaluated, but no construction plans have been made (URS Engineers 1981).

NOISE

Existing noise levels in the tract site areas are estimated to be approximately 40 to 45 decibels (db) (Department of Commerce 1977). The existing level of noise along Colorado Highway 13/789, between Rifle and Rio Blanco and along Piceance Creek Road (County Road 5), between Ryan Gulch and Rio Blanco is approximately 69 db.

Noise sources on-tract are primarily natural, such as wind, but additional noise comes from aircraft and nearby roads. A noise level of 50 db, at 1,000 to 3,000 feet, would blend into existing background noises. A level of 50 db is considered the threshold for uncomfortable noise for humans.

EXISTING RIGHTS

By leasing Tracts C-11 and C-18, five rights-of-way could be affected. The rights-of-way consist of two buried natural gas pipelines, two access roads and a buried telephone line (see Figure III-17).

Three public water reserves (see Figure III-17) on Tract C-11 would be adversely affected by the dewatering of the upper level aquifers.

100 percent of both tracts are currently leased for oil and gas. Twenty-five oil and gas leases (see Figure III-18) would be affected by the leasing of the two tracts.

Approximately 4,840 acres of Tract C-18 is currently being leased to Wolf Ridge Corporation for the mining of sodium (see Figure II-1, Chapter II).

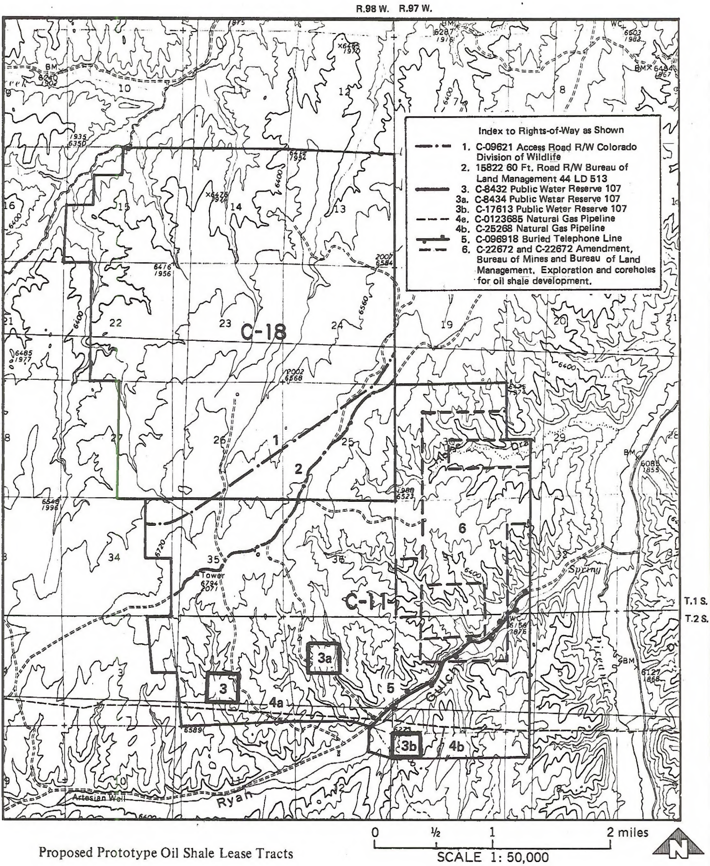
SURFACE RECLAMATION AND SOLID WASTE DISPOSAL

Reclamation of the mine facilities, surface retort, and true in-situ borehole activities associated with oil shale leasing would follow standard reclamation practices. Spent shale waste disposal would, however, require more intensive reclamation procedures due to high salinity, potential trace element toxicities, and stabilization problems.

Mine Facilities and Surface Retort Reclamation

Mine site and surface retort facilities would most likely be located in areas of relatively flat terrain requiring the least construction effort. These areas should have relatively good topsoil salvage. Reclamation of these areas under standard practices would entail removal of all structures, recontouring, replacement of subsoil and topsoil, construction of erosion control structures, seed bed preparation and seeding as required in the Environmental Stipulations of the lease, Section 11. Fertilizer and irrigation practices would follow during the first spring growth and continue until permanent revegetation is established. Fencing would also be necessary to protect the seedlings from livestock grazing until establishment. Establishment of suitable vegetation could be effective within three to four years after seeding.

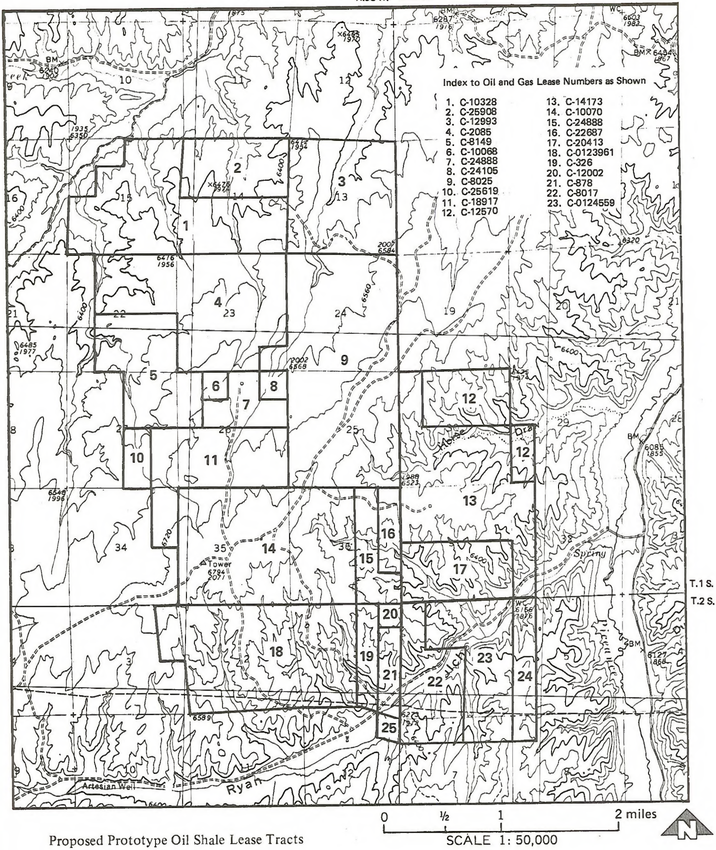
True in-situ borehole activities such as roads, pipeline routes, well pads and mine facilities would



Proposed Prototype Oil Shale Lease Tracts

Figure III-17 Surface Encumbrances, Shows Location of Pipeline, Road and Telephone Rights-Of-Way, and Public Water Reserves on the Tracts

R.98 W. R.97 W.



Proposed Prototype Oil Shale Lease Tracts

Figure III-18 Existing Oil and Gas Leases, Shows Location and Lease Numbers on Both Tracts

involve a large disturbance of the tract. Reclamation would closely follow disturbance which involves on several types of soil and vegetation. Intensive reclamation efforts may or may not be necessary on those areas which are sparse in vegetation with south to southwest facing steep slopes. Such sparse vegetation areas would be returned to a cover and composition similar to that which existed prior to disturbance. The principal emphasis would be soil stabilization during plant establishment.

Spent Shale and Shale Processing Waste Disposal

Spent shale waste would involve surface and underground disposal for both the direct mining with surface retort, and the mine assisted in-situ retort methods. Surface and underground disposal would require consideration of the physical and chemical properties of spent shale as factors that would affect reclamation. These factors are directly related and would vary by the type of retort process used. In addition to the spent shale, there would be other wastes associated with the retorting process and upgrading of the shale oil on site.

Processing of shale would produce spent catalysts, caustics, flocculents, filtering agents, trace elements, sanitary wastes and separator sludges (Crawford et al 1977). Shale oil coke is another expected product if the shale oil is upgraded onsite. If not sold (such as the shale oil coke), these processing wastes become a disposal problem similar to that of the spent shale. Studies have shown that for a 36,000 bbls/day shale oil production rate, these by-products and wastes would amount to only one to two percent (295,000 tons) of the total wastes produced annually (Crawford et al 1977). Similar percentages can be expected for a 25,000 or 50,000 bbls/day operation. Some of these wastes may classify as hazardous wastes under EPA criteria and should be disposed of accordingly. Otherwise, spent shale processing wastes are expected to be disposed of concurrently and in the same manner as retorted shale.

Factors affecting disposal practices of shale wastes involve expansion, compaction, cementation, permeability, seepage and leachates. These factors are directly related to the retorting process in terms of feed preparation, processing, duration, and temperature in the retort. As a result, the retorting process itself can have differing effects upon reclamation and disposal pile dynamics.

New waste disposal technology, refinements in the retorting process, and changes in environmental protection laws would provide changes that could enhance reclamation of spent shale wastes. Flexibility in reclamation techniques and laws is provided in the lease under the "Environmental Stipulations", Section 1.(B).

Expansion of Spent Shale

Expansion of shale is due to the crushing process it undergoes prior to surface retorting. When shale is crushed, its volume will double per unit mass; and during retorting 40 percent of this doubled volume will be burned off resulting in a 20 percent net gain in volume over raw shale that is in place (Bloomfield and Stewart 1981). For either the direct mining and surface retort or the mine assisted in-situ method, surface disposal of spent shale would be necessary due to a 20 percent expansion factor.

Compaction of Spent Shale

Compaction of spent shale would be crucial for adequate underground (backfilling) and surface disposal. Spent shale compacted to 100 pounds per cubic foot or greater would result in good strength and is essentially semipervious to impervious (Bloomfield and Stewart 1981). If spent shale is not compacted to this level, then problems associated with the natural cementation qualities, permeability, leachate quality and seepage probably would occur due to ground and surface waters entering the disposal piles. Compaction to this level may not be practical due to the expense of performing this task on a large scale.

Optimum compaction is obtained through the compressive strength of the spent shale. Compressive strength however, is dependent on retort temperature and retort residence time of the raw shale. Maximum compressive strengths of 270 to 325 pounds per square inch can be obtained at specific temperatures and time in the retort (Bloomfield and Stewart 1981).

Compaction strengths of unconfined spent shale should increase as the spent shale cures or settles. The compaction strength during curing can be affected by the moisture, temperature and particle size of the spent shale. Ninety percent of ultimate strength or more can be obtained in 16 to 28 days of curing (Bloomfield and Stewart 1981; Crawford et al 1977). Some processed shales show a fall off in compressive strength over time.

For underground disposal, compaction can increase the amount of spent shale to be stowed and increases resistance to saturation by groundwater. To enhance underground (backfilling) compaction strengths, the addition of flocculents and cementing agents generally do not work. However, a five to

one shale and cement mixture at 15 percent moisture content would increase compressive strengths after eight days of curing (Bloomfield and Stewart 1977). Compaction of surface disposal piles to a semipervious to impervious condition would be necessary to reduce the possibility of slope failure causing mass wasting.

Spent shale fills and embankments are more stable when compacted under dry conditions than under saturated conditions. Studies indicate slopes of two to one and three to one would be stable in dry and saturated piles respectively (Bloomfield and Stewart 1981; Crawford et al 1977). The likelihood of slope failure is reduced if spent shale piles are uniformly compacted with available equipment. Portions of a disposal pile that could induce slope failure are the boundary layers (interfaces) that can occur in a pile, such as (Crawford et al 1977):

1. Valley floor to pile sides
2. Compacted to noncompacted faces
3. Overburden to processed shale faces
4. Topsoil to processed shale faces

Cementation of Spent Shale

The natural cementing property of spent shale depends upon both particle size and retorting process. To a large degree, natural cementation will determine the stability and maintenance of the compactive strength of spent shale disposal piles. Harbert and Berg (1978), in their studies of vegetative stabilization of oil shale suggest that the natural cementation properties of spent shale will pose fewer long-term environmental problems. Depending on the retort process, spent shale will either be carbonaceous or decarbonized.

Carbonaceous shales are those shales which were retorted at low temperatures and contain five percent or more organic matter (Crawford et al 1977). Carbonaceous shales, due to their low temperature origin, will have poor cementing qualities at best (when moisturized and compacted). This would decrease the chance of forming a water impervious disposal pile. Leaching through the pile is therefore greater (Bloomfield and Stewart 1981) and pile instability could be increased.

Decarbonized shales are those shales which are processed utilizing residual carbonaceous organic matter as a fuel source for part of the retorting process. Decarbonized shales would have been retorted at approximately 900 degrees Fahrenheit (°F) or more and contain residual carbon of three percent or less. Burning (oxidation) of the residual carbon accompanied by calcining the carbonate minerals at higher temperatures could be a source of process energy resulting in nearly carbon-free shale ash. The result is a shale ash having a composition somewhat similar to Portland cement with certain cement-like properties. Some decarbonized shales with optimum moisture content can obtain 90 percent of its stability in disposal piles within 16 days of curing (Crawford et al 1977).

Grinding of decarbonized shale to finer particle size can enhance natural cementation and improve disposal pile strength (Crawford et al 1977). However, this fine grained material may deteriorate after prolonged exposure prior to compaction while more coarse material is thought to expose fresh reactive surfaces under compactive efforts (Bloomfield and Stewart 1981). If this is the case, then timing between retorting and disposal of spent shale would become important to obtain compactive strengths with the least effort (Bloomfield and Stewart 1981).

When sodium and aluminum minerals are extracted concurrently with oil shale, they will be stripped from the shale prior to and after retorting, respectively. Once removed, the effect upon natural cementation is presently unknown. Research should be conducted to see what changes, if any, occur and how it could affect the way spent shale wastes would be disposed.

Permeability and Seepage in Spent Shale Disposal Piles

Permeability of spent shale disposal piles can affect the compaction and cementation stability of a pile. Percolation of water into the surface layers of a disposal pile followed by successive periods of wetting and drying, freezing and thawing, deteriorates the effective compaction and cementation of the pile.

Permeability of a disposal pile is directly related to the compactive effort a pile receives and the type of spent shale being compacted. Decarbonized shales, although initially coarse-grained, can be compacted with less effort than fine grained carbonaceous shale to impervious and semipervious conditions. An impervious to semipervious condition reduces percolation significantly.

Seepage into spent shale disposal piles is directly related to the permeability of the compacted pile. Excess seepage into a disposal pile can cause slope failure and mass wasting resulting in reclamation failure. Greater compaction densities can result in lower seepage rates (Bloomfield and Stewart 1981), but higher runoff rates. This would require water diversions to prevent runoff scour and channelling into the piles. If lower compaction densities are used, then liners under the piles and catchment

basins will be necessary to collect any leachates resulting from increased seepage rates. Optimum seepage rates can be obtained by assuring optimum compaction based on the characteristics of the spent shale. Adequate compaction densities can be achieved through the use of grading and hauling equipment, however, compaction by this means may not be uniform causing higher seepage rates.

Leachates of Shale Disposal Piles

Successful reclamation of spent shale disposal piles depends on the ability to control the amount and quality of leachates at acceptable levels. Leachates of inorganic constituents, trace elements, total dissolved solids (TDS), salinity and pH are dependent upon compactive densities and the retorting process used (Bloomfield and Stewart 1981).

The use of higher temperatures in the retort can control the occurrence of some trace elements in the spent shale. For example, under certain conditions at temperatures (+2000°F) boron will become incorporated into insoluble forms of silicated minerals such as akermanite, monticellite and diopside (Stollenwerk and Runnells 1981).

Total Dissolved Solids will be generally higher in retorted shale leachates than raw shale leachates (Stollenwerk and Runnells 1981). Retorting temperatures that calcine the carbonate minerals will increase the amount of TDS due to an increase in soluble salts from decarbonized shales (Bloomfield and Stewart 1981). TDS levels in leachates from spent shale might be expected to decrease when soluble sodium minerals such as nahcolite are extracted during the processing of shale. Otherwise, TDS can be expected to increase in spent shale-bearing sodium minerals.

Leachate salinity of spent shale is affected by retort residence time and temperature. At very high temperatures, salinity content will decrease to some extent with increased retort residence time (Bloomfield and Stewart 1981). Moderate high retort temperatures, however, will increase the salinity of spent shale because decarbonized shales (more desirable for their natural cementation qualities) are calcined, and these are higher in soluble salt content. Therefore, studies should be conducted to find the retort residence time that would decrease or minimize soluble salt content in decarbonized shales to achieve leachates lower in salinity.

Within limited ranges leachate pH has been found to be directly related to increased temperatures in the retort. The pH of spent shale increases from 9.1 at 1000°F to 11.3 at 1400°F and is probably associated with the increased content of carbonates, hydroxides and alumina at higher temperatures (Bloomfield and Stewart 1981). A pH of 8.5 to 9.0 is considered the level that would inhibit plant growth. If spent shale is not made impervious to semipervious, then leachates of higher pH could be expected to cause problems when establishing plants for reclamation.

Control of leachates (if not through the retorting process) would require compactive densities of approximately 100 pounds per cubic foot to make the piles impervious to semipervious. Use of shale retort process water to moisten the spent shale to optimum condition for compaction is not expected to significantly lower the leachate quality from the shale (Bloomfield and Stewart 1981). Another method that can be used to control leachate quality from a disposal pile of spent shale would be to leach the material prior to placement and compaction. Initial leachates from a disposal pile of spent shale will fail to meet EPA recommended water quality criteria for molybdenum, boron, flouride and TDS (Stollenwerk and Runnells 1981). Leachate quality could be improved by leaching with one or two pore volumes of water through the pile to reduce molybdenum, boron and TDS. Fluoride however, will remain high after several leachings of pore volume (Stollenwerk and Runnells 1981). Once leached, piles will have to be drained to a moisture content suitable for compaction. However, leaching and draining of large quantities of spent shale as a final part of the processing or on large commercial scale disposal piles has not been conducted to test the effectiveness of such a practice.

Underground Shale Disposal

Underground disposal (backfilling) of spent shale, although more expensive than surface disposal, would reduce total impacts to the surface environment. Backfilling would reduce the potential for subsidence and increase resource recovery through stabilization, allowing for relatively thin support pillars (Bloomfield and Stewart 1981).

Utilizing the direct mining and surface retort method, 75 to 85 percent of the retort material could be placed back into the mine. This would reduce the land area required for surface disposal to 15 to 30 percent of that required for total surface disposal. At a production rate of 50,000 bbls/day, backfilling would decrease surface disturbance to approximately one-half to one acre per day (Bloomfield and Stewart 1981).

Utilizing the mine assisted in-situ retort method, a similar amount of retort material as that in the direct mining method could be placed back into the mine. At full production, the mine assisted in-situ method would decrease surface disturbance to approximately three-quarters of an acre per day.

The most efficient method to backfill a mine for underground disposal is the conveyor. This was found to be true for sublevel stoping, chamber and pillar mining. This method costs approximately twice as much as surface disposal, however, this cost could be offset by the benefit of less surface area requiring reclamation. Benefits of conveyor transport for backfilling are as follows (Bloomfield and Stewart 1981):

1. Low personnel and energy requirements.
2. Low capital and operating costs.
3. Highest pillar support potential.
4. Greatest ability for increased resource recovery.
5. Most retorted shale placement.
6. Least surface disturbance, groundwater contamination, and environmental degradation.
7. Safest overall method.

Aboveground Shale Disposal

Surface disposal of spent shale will occur during two phases: 1) mine development, and 2) development of overlying shale zones above the saline zone (during full shale oil production starting in 1993). This would primarily be 20 to 60 percent of spent shale material that could not be backfilled after surface retorting and would disturb approximately 1000 acres or less with the direct mining and surface retort or mine assisted in-situ methods respectively.

Aboveground disposal of spent shale could decrease total surface disturbance by 200 acres if the 1000 acres needed for disposal is overlapped onto the disturbance of the mine facilities as the mine is abandoned. This would depend, however, on the sequencing of final retorting and mine facility withdrawal. Stockpiling of the spent shale for a short period of time would be necessary. However, the main advantage of this would be the reduced cost of not having to strip the disposal area of topsoil, since it would have already been stripped to build the mine facility.

Topsoil or other suitable soil material would be needed to top-dress spent shale disposal piles, reducing the effects of extreme surface temperatures and soluble salts. A capillary barrier would also be necessary to prevent upward migration of soluble salts if not leached below the root zone.

If shrub roots penetrate the spent shale due to insufficient top-dress, then transport and accumulation of molybdenum and boron may occur in the plants (Redente and Cook 1981). Fluoride, which is soluble in spent shale, may also accumulate in these deeper rooting plants. Studies indicate that plants may also accumulate high levels of molybdenum and zinc (Harbert and Berg 1978). Consideration as to the shrub species rooting depth is needed in order to prevent possible molybdenosis and fluorosis in animals which would later graze the area.

Because of the potential for upward migration of salts when irrigation ceases, only shallow rooted, salt tolerant plants would be expected to remain in a vegetation community established in a spent shale pile covered with too little topsoil. Also, compacting a spent shale pile to the point where it is semipervious or impervious to water would make the spent shale pile impenetrable to roots, especially deep rooted species such as shrubs. Therefore, depth of the topsoil or suitable soil becomes important to establish a diverse and stable vegetative community. Small plot studies on reclamation of spent shale piles have been made on topsoil depths ranging from 11 to 35 inches (Harbert and Berg 1978; Redente and Cook 1981). Depths of approximately 11 inches required intensive fertilizer and irrigation treatments to reclaim the site. These small plot short-term studies may not adequately reflect environmental conditions on a commercial scale spent shale disposal pile. Some studies suggest that at least 24 inches of suitable plant growth material would be necessary to establish a permanent and diverse plant cover which would be stable over time.

Assuming that the spent shale disposal piles are placed on areas with the shallowest soils, 2,090,000 cubic yards of suitable plant growth material would be available for salvage. This is sufficient to cover the pile to a depth of 15 inches. Because of compaction during placement, settling, and erosion of topsoil material, as little as eight inches could be available for plant growth over time. To cover the pile to a depth of 24 inches, an additional 1,137,000 cubic yards of soil are needed.

Additional suitable soil could be obtained elsewhere on the lease tracts, however, the availability of suitable plant growth material is limited. Only about 1,103,000 cubic yards of suitable plant growth material are available on Tract C-11 and about 2,755,000 cubic yards of suitable plant growth material are available on Tract C-18. In order to adequately top-dress a 1000 acre spoil pile on Tract C-11, the disturbance of an additional 800

acres may be required. In order to adequately top-dress a 1000 acre spoil pile on Tract C-18, the disturbance of an additional 700 acres may be required.

Use of subsoil excavated at the disposal sites as suitable plant growth material, can decrease the amount of surface disturbance and provide better depth coverage. Perhaps depths greater than 24 inches of top-dress can be obtained at lower cost by excavating additional subsoil at the disposal site rather than hauling in topsoil from elsewhere on the tract. It may be possible to obtain additional suitable plant growth material off of the lease tracts.

Topsoil, once excavated from a disposal pile site, should be replaced as soon as practical to avoid the loss of mycorrhizal and microbial organisms in the soil that are necessary for the success of re-seeded plants. Long-term storage of topsoil without vegetative cover decreases the infection potential significantly and therefore decreases the relative success of revegetation (Redente and Cook 1981).

Revegetation of spent shale disposal piles and mine facilities sites after topsoil coverage would be dependent upon the seed mixtures, irrigation rates, fertilizer type and rates, and short and long-term climatic conditions. Shrubs seeded at two times the rate of grasses will obtain only one-quarter of the total biomass of the established stand; lesser rates of shrubs will favor grass dominance (Redente and Cook 1981). Irrigation and fertilization only accentuate this effect on both favorable and rocky sites.

Topsoil over spent shale piles would eventually erode, exposing spent shale regardless of placement. Exposed piles will exhibit a thin crust of sodium and calcium sulfate particularly during hot weather when evaporation rates are high (Crawford et al 1977).

Exposed spent shale subjected to average erosion in Piceance Basin might contribute 150 pounds of salt per acre along with three tons/acre of suspended material to surface waters annually (Crawford et al 1977). Proper disposal pile location and revegetation practices should not expose spent shale by erosion in the foreseeable future.

An additional impact from spent shale exposure is a result of its dark color. Exposed to direct sunlight, spent shale can reach temperatures of 149°F (Redente and Cook 1981). Such high temperatures would be detrimental to seedling establishment.

Location of Shale Disposal Piles

The location of the spent shale disposal areas would dictate how rapidly topsoil cover would erode and expose the shale. Two possibilities exist for surface disposal of spent shale: 1) deposit spent shale in gently sloping areas, and 2) deposit spent shale in the heads of draws, filling the draws so the only steep watershed is the face of the fill material.

To minimize the effects of erosion, disposal sites should be located in small watersheds or ridges with sideslopes of 4 to 1 or less. This is the maximum slope at which revegetation success is still good. Slopes of 4 to 1 or less should also have control structures to reduce erosion.

Monitoring of Shale Disposal Piles

Depending on state and federal regulations to prevent shale leachate contamination of surface and groundwaters; monitoring may be required for many years after mine productivity ends. Such monitoring beyond initial vegetative establishment and reclamation becomes less economical with each additional year of monitoring beyond the life of the mine. If, for economic reasons, monitoring should stop, then leachates could occur without resolve. Consolidation of spent shale wastes to a solid rock-like form is recommended to decrease the surface area of the spent shale when it is exposed. This form would minimize leachates to a quality that would not significantly decrease normal water quality. Consolidation may initially cause an added expense to disposal costs, however, this cost is expected to be offset by the dollars saved from shortened monitoring periods. If, for economic reasons, monitoring should cease, then control of leachates to protect Colorado ground and surface waters would become the financial responsibility of the federal government.

Conclusions

While a great deal of research has been done on reclamation and spent shale disposal, considerable work must still be done to assure successful rehabilitation. The reclamation plan submitted with the Detailed Development Plan must be carefully examined and monitored to avoid unnecessary and potentially serious impacts to the site, to the surface and groundwater and to the long-term productivity of the soil and vegetation on-tract.

Spent shale requires special handling and treatment procedures unique to the resource, while traditional reclamation practices should be effective in reclaiming areas of surface disturbance.

CHAPTER IV

ENVIRONMENTAL CONSEQUENCES

CHAPTER IV
ENVIRONMENTAL CONSEQUENCES

AIR QUALITY

As outlined in Chapter III, Air Quality, several atmospheric pollutants in the study region are approaching or exceed air quality standards. Any new emission source in the region would compound this situation. In order to determine the contribution of additional prototype developments to these impacts, pollutant concentrations were estimated using the Topographic Air Pollution Analysis System (TAPAS). TAPAS is a system composed of several air quality-related computer models. These models predict the resulting ground level concentrations by taking into account topography, ground cover (surface roughness), wind speed and direction, and industrial plant emission characteristics.

TAPAS was employed to determine worst-case pollution concentrations throughout the region, particularly from long range transport over complex terrain into nearby pristine areas. The following steps were neccessary during the analysis:

- Specification of the modeling region to determine boundaries, topography, ground cover, background pollutant concentrations, emission factors, sources and sensitive receptors.

- Alternative wind field analyses to determine the worst-case meteorologic transport conditions.

- Modeling of pollutant sources concurrently with wind field analyses.

- Scaling and combining various sources under all analysis scenarios to determine predicted ground level pollutant concentrations.

- Prior to applying the models, several assumptions/conditions were established. They are:

  - Air Quality standards violations would be caused first under 24 hour worst-case conditions.

  - Only Total Suspended Particulates (TSP), Sulfur dioxide (SO_2) and Nitrogen oxides (NO_x) criteria pollutants would be emitted in significant amounts.

  - A two-minute grid scale (each grid approximately 2.9 by 3.7 km in size) would be large enough to contain the most sensitive areas and still provide adequate resolution of concentration values.

  - Scenarios and emission factors used for the Uinta Basin Synfuels EIS and the Programmatic Oil Shale EIS have been incorporated into the prototype analyses.

  - Emission rates for direct mining and surface retorting (DM/SR) and mine assisted in-situ (MAIS) development processes would be provided by the Minerals Management Service. Since reliable emissions values for true in-situ development at 25-50,000 bbls/day capacity are not available, this technique could not be modeled. Emissions will be controlled by the Best Available Control Technology (BACT) including: wet/chemical supression, covered conveyors, and baghouse controls of dust; electrostatic precipitation and wet scrubbing of combustion particulates; low NO_x burners; flue gas desulfurization; CO incineration; wetting and compacting spent shale; floating roof and conservation vents on fixed roof fuel storage tanks; and, smokeless vent gas flare designs.

  - High production levels, worst-case analysis would be performed first to limit the amount of modeling necessary to screen pollutant impacts.

  - Maximum emission levels, including major new sources in addition to federal oil shale development, would be reached by 2003.

  - Based on monitoring results and basic modeling techniques (Turner 1969), input parameters would be selected to minimize atmospheric mixing, including: a west wind at 4 meters per second, an effective plume rise above ground level of 300 meters, Pasquill stability Class E (stable) and a wet adiabatic lapse rate.

  - Due to the general, preliminary nature of the anticipated scenarios, specific development details are lacking. Therefore air pollutant impacts must be modeled conservatively (overemphasizing impacts) and generically. Actual industrial development will require detailed monitoring and modeling to obtain necessary air quality permits (i.e. detailed development NEPA analysis, PSD permit review, Major Fuel Burning Installation approval, Colorado Air Contaminant Emission Notice and Permit, and others). Therefore, the worst case assumptions and computer results expressed in this environmental statement should not necessarily be construed as a basis for deciding not to lease.

- Impacts to Air Quality-Related Values (AQRVs) in sensitive areas would be predicted through rudimentary acid deposition calculations and established visibility screening analysis (Latimer and Ireson 1980).

The following discussion summarizes the extensive modeling results. A detailed presentation of the modeling activities is found in *Air Qulaity Impact Assessment for the Supplemental Environmental Impact Statement for the Prototype Oil Shale Leasing Program* (Dietrich, et al 1982).

Figure IV-1 shows the region modeled, grid size, topography, new emission sources, and sensitive receptor locations. Table IV-1 lists the emission totals for sources located in Figure IV-1 and anticipated emissions from additional prototype development under various scenarios.

Too little information is available to adequately define regional background pollutant concentrations throughout the study area. Only predicted impacts from new major emitting facilities are reported below. As summarized in Chapter III, Affected Environment, nearly every town in the study area already violated the TSP Ambient Air Quality Standard; rural levels range from 10 to 40 micrograms per cubic meter. Where measured, SO_2 and NO_x levels are well within standards.

When compared to other energy-related projects in the region, secondary impacts from supplemental prototype leasing will be minimal - but any additional pollution will aggrevate the TSP problem. The most probable pollution increases in towns will be TSP, NO_x and CO, but to accurately predict regional pollutant levels due to secondary sources 20 years in the future is beyond the scope of this analysis. The significance of TSP violations will change once the EPA implements a fine particulate standard. Also, the Colorado Department of Health, Air Pollution Control Division, is currently determining urban and rural pollutant levels in each county; further efforts will be necessary to determine impacts from non-major emitting facilities.

Table IV-2 summarizes the maximum 24 hour predicted concentrations for TSP, SO_2 and NO_x from new sources in 2003. Even without additional federal oil shale leasing, violations of the primary National Ambient Air Quality Standards (NAAQS) near Rifle, Colorado, and PSD Class II incremental standards violations are anticipated east of the proposed power plant near Mack, Colorado (for location, see Figure III-1). PSD Class I incremental SO_2 standards would also be violated in the Mt. Zirkel Wilderness Area. These impacts are based on 2003 high level emissions without any additional federal leases. If all proposed federal lease developments occur at the 2003 high level, Class I SO_2 PSD increment violation is also anticipated in the Flat Tops Wilderness Area. Figures IV-2, IV-3, and IV-4 show these anticipated ground level concentrations for TSP, SO_2 and NO_x, respectively.

To assess the contribution of anticipated prototype leasing to the above total concentrations, impacts for these sources were modeled independently for two development techniques at four production levels. Results are summarized in Table IV-3 and IV-4, and displayed in Figures IV-5, IV-6 and IV-7. A Class I SO_2 PSD increment violation is anticipated under the highest production level mine assisted in-situ development scenario. Violations of PSD Class I or II increments are not anticipated under other scenarios.

As recommended by the EPA in their *Workbook for Estimating Visibility Impairment* (Latimer and Ireson 1980), a Level 1 screening analysis was performed to assess visibility impairment from the proposed prototype lease development. Results of the analysis (Dietrich, et al 1982), indicate development at 50,000 or 100,000 bbl/day by the mine assisted in-situ technique may cause adverse visibility impairment chiefly from TSP and NO_xemissions. No impairment is anticipated under any other development scenario. Since detailed development data is unavailable, Level 2 and Level 3 analyses could not be performed. Further analyses will be required during the PSD permit review process.

Impacts to other AQRV's in PSD Class I areas are also a concern as air contaminant levels increase; particularly sulfur and nitrogen-related compounds. However, current knowledge of pollutant transport and chemical transformation is limited, and the general processes affecting AQRV's are not well understood. A rudimentary assessment of worst-case 24 hour deposition in the study area was performed by Dietrich et al (1982) assuming elemental sulfur and nitrogen deposits are solely formed from SO_2 and NO_x, respectively. It must be emphasized that deposition values were calculated from worst-case concentrations at a single point; concentration values drop rapidly at surrounding points (each grid point represents nearly 11 km^2; the Flat Tops Wilderness Area is nearly 950 km^2 in size).

Under the 2003 high level mine assisted in-situ scenario, single point sulfur and nitrogen deposition rates resulting from all new emission sources (including federal leases) will be 40 and 140 grams per hectare-day (gm/ha-dy), respectively. Maximum prototype lease development contributions would be 22 and 57 gm/ha-dy of sulfur and nitrogen. On an annual basis (assuming annual concentrations will be 20 percent of the 24 hour maximum values), deposition rates will be 2.9 and 10 grams per hectare-year (gm/ha-yr) of sulfur and nitrogen from all sources; 1.6 and 4.2 gm/ha-yr of sulfur and nitro-

TABLE IV-1
EMISSION TOTALS FOR NEW SOURCES (gm/sec)

Source	1993 Low TSP	1993 Low SO_2	1993 Low NO_x	2003 Low TSP	2003 Low SO_2	2003 Low NO_x	1993 High TSP	1993 High SO_2	1993 High NO_x	2003 High TSP	2003 High SO_2	2003 High NO_x
Oil Shale Tracts												
Cathedral Bluffs	0	0	0	28	21	111	28	21	111	64	56	333
Chevron	0	0	0	36	35	222	36	35	222	72	69	444
Colony	6	35	31	6	35	31	6	35	31	6	35	31
Mobil	0	0	0	0	0	0	0	0	0	36	35	222
Rio Blanco	0	0	0	36	35	222	36	35	222	72	69	444
Superior	0	0	0	0	0	0	0	0	0	7	7	44
Union	7	7	44	36	35	222	36	35	222	69	62	400
Power Plants												
Craig	122	425	865	122	425	865	122	425	865	122	425	865
Moon Lake	31	53	562	31	53	562	31	53	562	31	53	562
Southwest	14	131	291	44	392	874	14	131	291	44	392	874
Coal Gasification												
W.R. Grace	68	47	271	68	47	271	68	47	271	68	47	271
Sodium Mine												
Multi Mineral	3	1	6	3	1	6	3	1	6	3	1	6
New Federal Lease (Programatic)	0	0	0	70	64	414	70	64	414	212	194	1124
Prototype Leases												
25,000 bbl/day MAIS	25	52	232	-	-	-	-	-	-	-	-	-
25,000 bbl/day DM/SR	12	14	69	-	-	-	-	-	-	-	-	-
50,000 bbl/day MAIS	-	-	-	50	106	466	50	106	466	-	-	-
50,000 bbl/day DM/SR	-	-	-	25	28	138	25	28	138	-	-	-
100,000 bbl/day MAIS	-	-	-	-	-	-	-	-	-	100	212	932
100,000 bbl/day DM/SR	-	-	-	-	-	-	-	-	-	50	54	276

Source: Dietrich, et al, 1982.

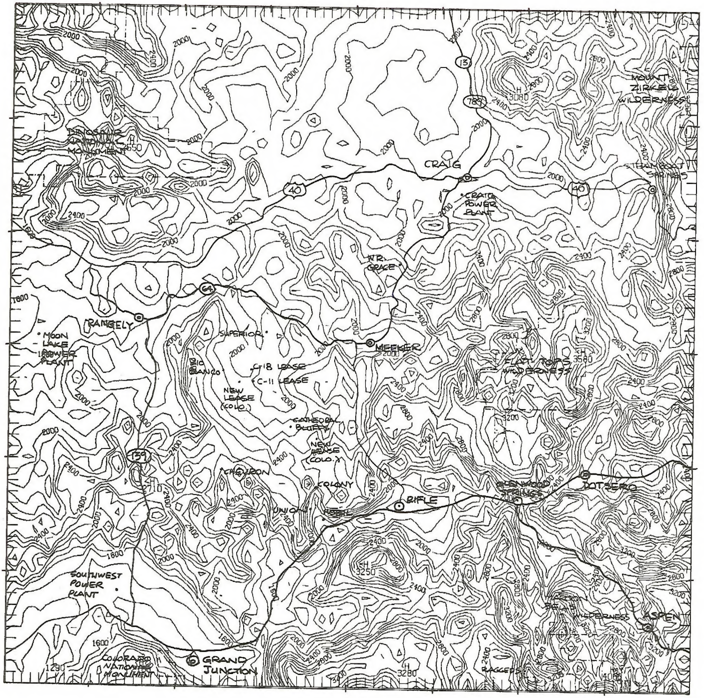


Figure IV-1 Prototype Air Quality Analysis Study Area (elevation in meters)

TABLE IV-2
MAXIMUM 24 HOUR PREDICTED POLLUTANT CONCENTRATIONS (micrograms/cubic meter)
2003 HIGH LEVEL MINE ASSISTED IN-SITU SCENARIO

Sensitive Areas	No Action Alternative TSP	SO_2	NO_x	Combined Alternative TSP	SO_2	NO_x
Class I Areas						
Flat Top Wilderness	2.2	2.2	17.4	7.0	9.4	54.1
Maroon Bells/Snowmass Wilderness	0	0	0	0	0	0
Mt. Zirkel Wilderness	0.9	10.1	20.5	2.9	10.1	20.5
Primitive Class II Areas						
Book Cliffs	16.6	147	(329)	16.6	147	(329)
Colorado Nat'l Monument	0	0	0	0	0	0
Dinosaur Nat'l Monument	0	0	0	0	0	0
Southeast of Flat Tops	15.7	13.6	90.8	45.0	28.1	(158)
Developed Class II Areas						
Near Craig, CO	12.3	42.9	87.3	12.3	42.9	87.3
Near Rifle, CO	[704]	[865]	(4100)	[704]	(866)	(4101)
Near Steamboat Spgs, CO	0	0	0	0	0	0
Air Quality Standards						
Class I Increments	10	5	-	10	5	-
Class II Increments	37	91	-	37	91	-
Ambient Air Quality						
- Primary	260	365	(100)	260	365	(100)
- Secondary	150	-	-	150	-	-

Source: Dietrich, et al, 1982

Notes: Bracketed values violate primary Ambient Air Quality Standards
Single underlined values violate Class II PSD incrementss
Double underlined values violate Class I PSD increments.
Parenthetic values compare 24 hr. concentrations to annual Ambient Air Quality Standards for NO_2.

TABLE IV-3

MAXIMUM 24 HOUR PREDICTED POLLUTANT CONCENTRATIONS (micrograms/cubic meter)
IMPACTS FROM MINE ASSISTED IN-SITU PROTOTYPE DEVELOPMENT ONLY

Production Scenario	Maximum TSP	Maximum SO_2	Maximum NO_x	Flat Tops TSP	Flat Tops SO_2	Flat Tops NO_x
No Action	0.0	0.0	0.0	0.0	0.0	0.0
25,000 bbl/day	19.0	13.0	58.8	0.8	1.2	5.5
50,000 bbl/day	21.8	26.6	118	1.5	2.5	11.0
100,000 bbl/day	30.3	38.7	171	3.0	5.0	22.1
PSD Increment	37	91	--	10	5	--

Source: Dietrich, et al, 1982.
Note: Double underlined values violate Class I PSD increments.

TABLE IV-4

MAXIMUM 24 HOUR PREDICTED POLLUTANT CONCENTRATIONS (microgram/cubic meter)
IMPACTS FROM DIRECT MINING AND SURFACE RETORTING PROTOTYPE DEVELOPMENT ONLY

Production Scenario	Maximum TSP	Maximum SO_2	Maximum NO_x	Flat Tops TSP	Flat Tops SO_2	Flat Tops NO_x
No Action	0.0	0.0	0.0	0.0	0.0	0.0
25,000 bbl/day	5.2	3.5	17.5	0.4	0.3	1.6
50,000 bbl/day	10.9	7.0	34.9	0.8	0.7	3.3
100.000 bbl/day	15.2	9.9	50.6	1.5	1.3	6.5
PSD Increment	37	91	--	10	5	--

Source: Dietrich, et al, 1982

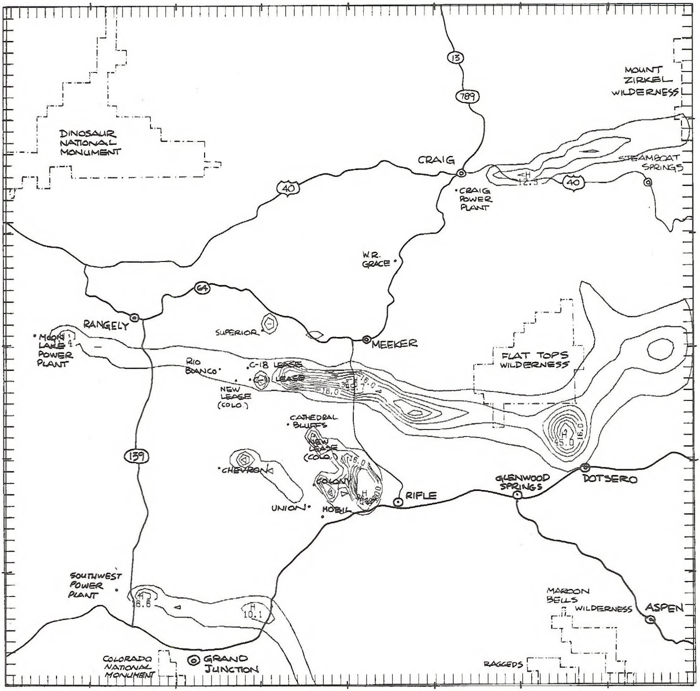


Figure IV-2 Air Quality. Ground Level Concentrations for Mine Assisted In-Situ, High Production for TSP, All New Sources

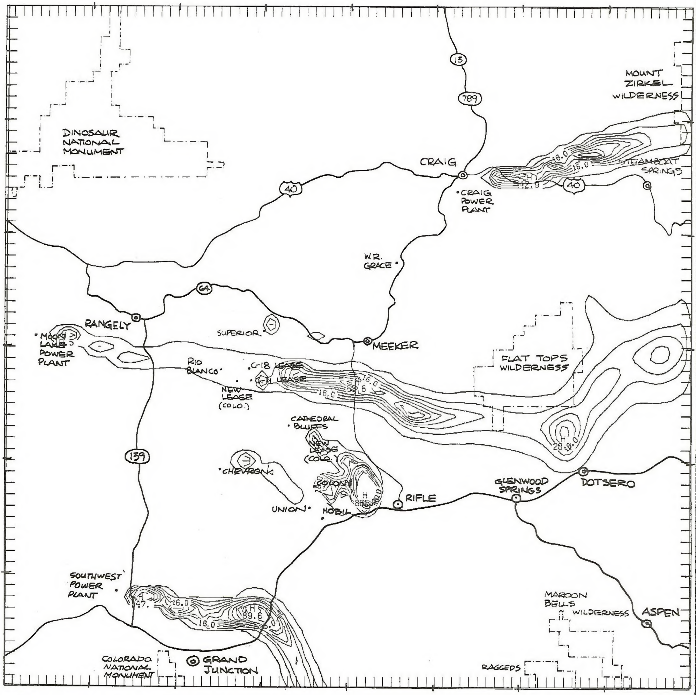


Figure IV-3 Air Quality. Ground Level Concentrations for Mine Assisted In-Situ, High Production for SO_2, All New Sources

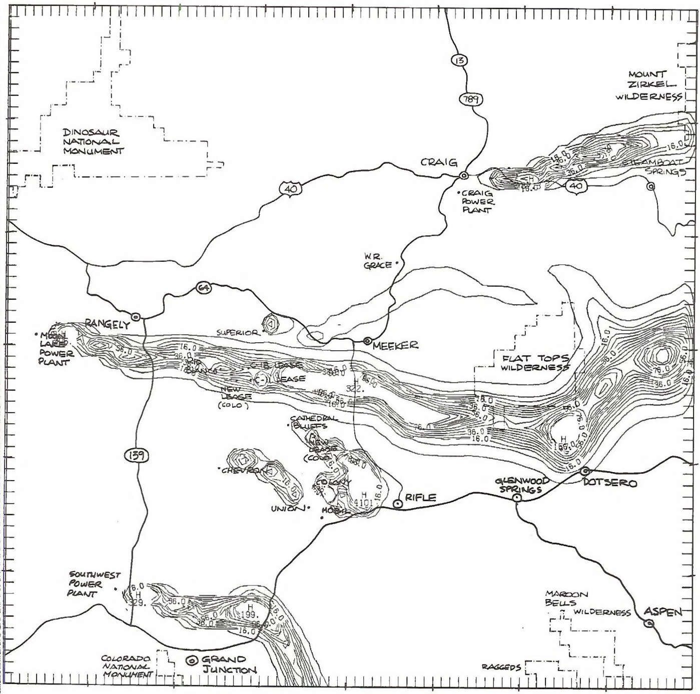


Figure IV-4 Air Quality. Ground Level Concentrations for Mine Assisted In-Situ, High Production for NO_x, All New Sources

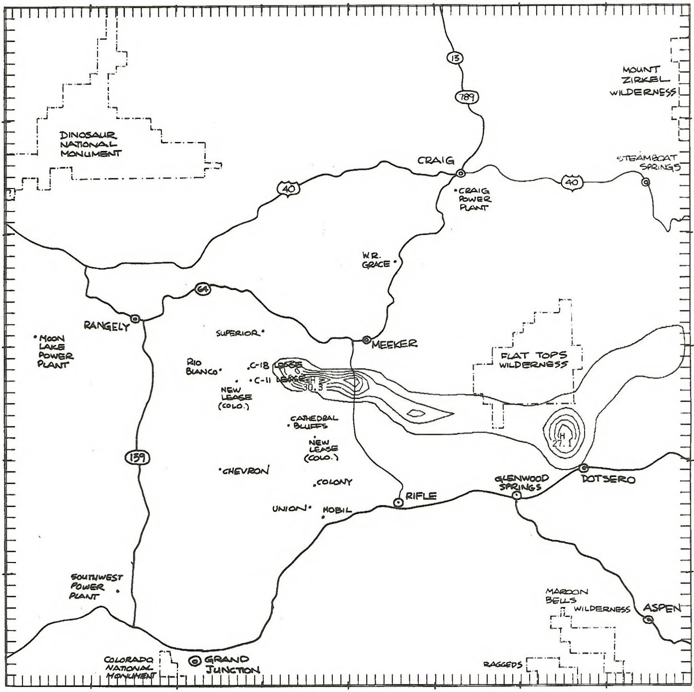


Figure IV-5 Air Quality. Ground Level Concentrations for Mine Assisted In-Situ, High Production for TSP, Tracts C-11 and C-18 Only

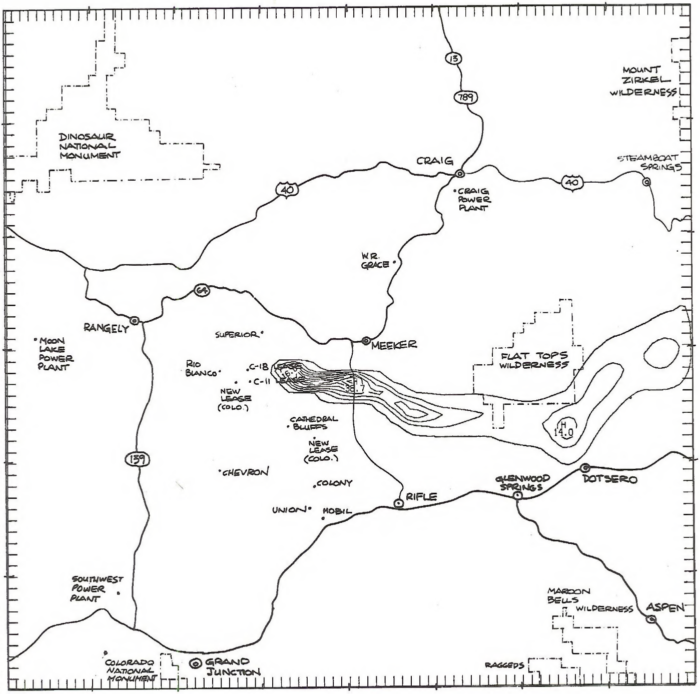


Figure IV-6 Air Quality. Ground Level Concentrations for Mine Assisted In-Situ, High Production for SO_2, Tracts C-11 and C-18 Only

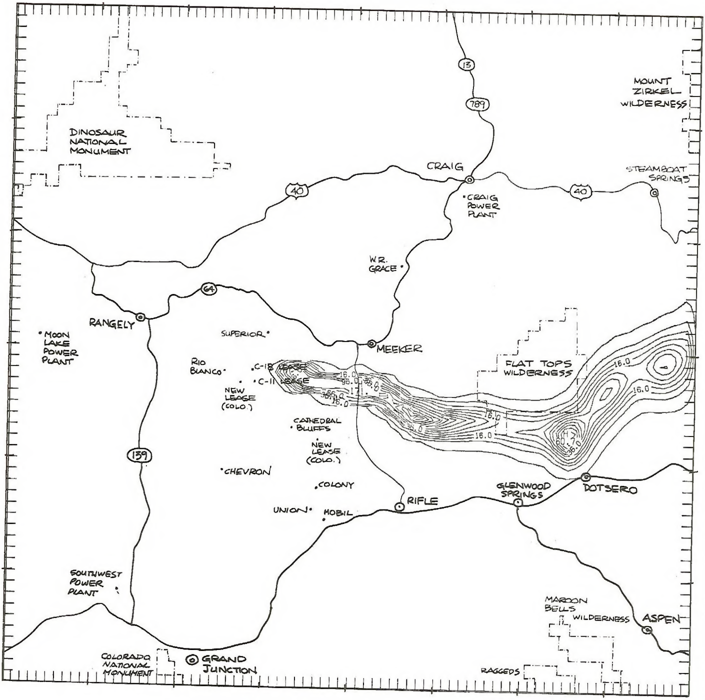


Figure IV-7 Air QUality. Ground Level Concentrations for Mine Assisted In-Situ, High Production for NO_x, Tracts C-11 and C-18 Only

gen from maximum prototype development sources alone.

Since impacts to the Rifle, Colorado area appeared to be severe under the west wind analyses, northwest wind analyses were also performed to determine the maximum possible impacts. Under the 2003 high level mine assisted in-situ scenario, additional ground level pollutant concentrations of TSP, SO_2 and NO_x will be 1671, 1625, and 10,308 micrograms per cubic meter, respectively; several times above the Ambient Air Quality Standards. These standards will also be exceeded east of the Flat Tops Wilderness Area (TSP - 313, SO_2 - 1090, and NO_x - 2220) and near Craig, Colorado (SO_2 - 664 and NO_x - 1352). The Class I SO_2 PSD incremental standard is expected to be exceeded at a ground level concentration of 10.7 micrograms per cubic meter within the Flat Tops Wilderness Area. All of these violations will occur without any additional Federal lease development. Impacts from prototype lease development are well within standards and would not contribute to the above violations.

In summary, pollutant emissions from direct development of additional prototype leases and induced, secondary sources will have an unavoidable, adverse impact on air quality, and unless both leases are developed with mine assisted in-situ technology at 50,000 bbl/day each, these impacts will be minimal. Substantial impacts to air quality will be caused by other private industrial sources in the region. Stipulations in new oil shale leases will assist in minimizing impacts by requiring: compliance with all applicable air quality statutes, regulations and standards; a baseline and continuing on-site air quality/meteorology monitoring program; an approved air quality control program; and specifically requiring "sprinkling, oiling, or other means of dust control" on roads and generally "make every reasonable effort to avoid ... dust problems" (Environmental Stipulations of the lease, Section 8).

After 2013, (for modeling purposes) when the developed area will be stabilized and decommissioned, no direct impacts to air quality will remain, but irreversible and irretrievable damage could occur because of established urbanization in the region. Additionally, short-term impacts to air quality may be alleviated by natural cleansing processes, but cumulative impacts to human health and vegetation could remain after mine abandonment. Uncommmited mitigation of these impacts could include additional control of emissions from existing sources, increased study of pollutant impacts to AQRVs, and additional background monitoring to better assess regional impacts.

CLIMATE

In the area immediately surrounding a shale oil development, local wind patterns may be affected by alteration of the topography or building construction. Land clearing could alter the reflection and evapotranspiration of the ground resulting in temperature and humidity changes. Industrial cooling towers would also affect humidity and could increase the occurance of ground fog. All of these potential impacts would be very localized and most would be mitigated through vegetative reclamation and the eventual decommissioning of the industrial facility.

Industrial combustion sources all produce fine particulates and carbon dioxide which may lead to global temperature changes (Council on Environmental Quality 1981), but development of additional prototype lease tracts would contribute insignificantly on this scale. No significant impacts to regional climate are anticipated due to any of the proposed lease action alternatives.

GEOLOGY AND MINERAL ACTIVITY

No Action Alternative

With the exception of current oil and gas exploration and possible development of the existing and Preference Right Lease Applications, no additional impacts on the mineral resources of the two tracts would occur under the No Action Alternative. Current oil and gas exploration and field development programs could proceed on schedule without interference from oil shale development. Construction of the proposed LaSal pipeline, designed to cross through Tracts C-11 and C-18, could proceed unimpeded if rescheduled.

The mineral resource beneath the lease tracts would remain intact except for portions of Tract C-18 that might be developed under existing sodium leases. Assuming that advances and breakthroughs in mining and retorting technologies might occur as the result of development at existing private and Federal oil shale sites, future production of oil shale and associated minerals from these tracts could possibly win a larger percentage of the in place resource if leased at a later date.

The approved mine plan prepared by Multi Minerals Corporation for the sodium lease on Tract C-18 calls for mining from several zones an average 6.5

foot thick zone of nahcolite and oil shale from the saline zone. Oil shale recovered from the room-and-pillar operation will be stockpiled on the surface until sufficient areas have been mined to allow backfill and underground storage (approximately 5 years).

Underground storage in mined-out rooms will protect the oil shale from weathering and deterioration but would require a variance from the Mine Safety and Health Administration (MSHA) for backstowing with a combustable material. Backfilling will also help prevent subsidence, thereby protecting overlying oil shale resources.

Projected mining rates will produce 1,670,000 tons of nahcolite ore per year. Approximately 400,000 tons/year of low-grade (oil shale) material will be stored and ultimately backfilled in the mine. This would result in a projected permanent loss of 270,000 tons/year of low-grade ore. Over a 50 year mine life, a total of 13.5 million tons of oil shale will be lost representing approximately 8 million barrels of oil. This amounts to less than 0.3 percent of the estimated recoverable shale oil on the lease tract.

Three additional Sodium Preference Right Lease Applications (PRLAs) are being evaluated by the Bureau (Chapter II, Section B). If the leases are issued then subsequent mine development is expected to proceed under this alternative.

Development Alternatives

Leasing Tracts C-11 and C-18 will impact the mineral resources on 10,236.22 acres. Only a small percentage of in place resources are recoverable by present technologies. Approximately 20 percent of the total oil shale resource, 14 percent of the in place nahcolite and 13 percent of the estimated dawsonite can feasibly be recovered. Using the most advanced mining, milling and retorting processes currently available will result in an approximate permanent loss of at least 80 percent of the estimated resource as unmined intervals, pillars, and process inefficiencies (see Table IV-5, Estimated Impact on Resource Base - Tracts C-11 and C-18) with nominal improvements in extractive technology, the amount of resource recovery would improve significantly.

The development of oil shale and sodium mining operations on Tracts C-11 and C-18 will not impact any other mineral resource except oil and gas. Possible deep coal deposits that lie beneath the Green River Formation are remote in likelihood of being mined.

Current lease stipulations require that oil and gas drilling not interfere with mining and recovery of oil shale deposits or result in undue waste of the oil shale resource. Wells must be cased, plugged and abandoned if it is determined that they will interfere with orderly oil shale development.

Drilling cost increases may occur due to casing requirements to develop oil and gas areas previously mined for oil shale. Minerals Management Service policy states that while oil and gas reserves may be developed simultaneously with the oil shale industry, drilling should not unduly interfere with solid mineral extraction. The currently proposed lease stipulations protecting oil shale lands should be enforced in areas of immediate development of oil shale while, at the same time, allowing continued drilling operations.

These stipulations amount to complete subordination of oil and gas drilling to oil shale development on new leases. Current MMS practices will allow oil and gas drilling on oil shale lands subject to the protection stipulations.

The development of underground mining does not necessarily preclude oil and gas drilling. Depending on well density, mining may progress leaving pillars around each well to protect its integrity. Assuming a pillar with a radius of 100 feet is left surrounding each well, 0.72 acre of oil shale land would be lost per well. Estimated recoverable shale oil is 234,000 to 410,000 bbls/acre. Each well permitted on the lease tracts could conceivably delay or prevent the extraction of up to 295,000 bbls/acre or 72 percent of the recoverable oil shale on the acre surrounding the well.

Recovery

Direct Mining -- The oil shale interval is approximately 1,600 feet thick on the lease tracts including the Mahogany and Saline Zone shales. Of this, approximately 40 percent may be economically mineable. Assuming a maximum recovery of 20 percent of the mineable oil shale, the net recovery of the in place resource is only 8 percent. This assumes that all beds greater than 25 feet thick and averaging 30 gal/ton are mined. Overall resource recovery might increase to 24 percent if it were found to be economically feasible to mine beds as thin as 10 feet in thickness.

Direct mining with surface retorting would allow mining to progress downward on multiple mine levels through the saline zone and within the Mahogany Zone.

Mine Assisted In-Situ -- Mine assisted in-situ development has the potential to produce shale oil in commercial quantities by utilizing wider intervals of oil shale than can be directly mined and surface retorted. Resource recovery is somewhat improved

over direct underground mining because a longer interval of resource can usually be processed. Up to 75 percent of the oil shale resource in a mining block (defined as that shale either directly mined or processed in-situ) can be expected to be recovered.

True In-Situ -- Low oil recoveries are currently associated with true in-situ processing due to the large unretorted blocks of shale left in the fractured formation or loss of shale to formation overbreakage. Irregular fracturing patterns can cause the heat carrier to by-pass or channel around sections of the deposit. Oil shale that is located in the by-pass areas will not be retorted. Another problem is that some of the oil does not reach the production wells, but remains trapped in the pores of the spent shale or diffuse beyond the production wells, to be lost in the surrounding strata.

Extraction of Minerals in the Saline Zone

Tests performed at the Bureau of Mines facility at Horse Draw indicate that nahcolite was found to have a compressive strength of 15,000 pounds per square inch (psi) as compared to 12,000 psi for oil shale. These rock strengths indicate good potential for room-and-pillar mining with large room widths. Using room-and-pillar mining in the saline zone, Multi-Mineral Corporation predicts 40 percent resource recovery from the Love Bed (up to 12 feet thick). Large pillars must be left in place to prevent mine subsidence and protect overlying aquifers and oil shale zones.

Mine assisted in-situ mining and processing will extract approximately 10 to 15 percent or more of the in place resource than will direct mining and surface retorting.

True in-situ processing may be technologically feasible for the saline zone. In the saline zone, the soluble minerals would be dissolved, pumped to the surface and recrystalized. Oil shale would subsequently undergo thermal decomposition to liberate kerogen.

True in-situ recovery of soluble sulfur, sodium chloride and other saline minerals, and uranium has been proven technically and economically feasible at many locations throughout the country. Recoveries are generally good, up to 75 percent for homogenous bedded saline deposits, but are poor (less than 20 percent) for zones that must depend on natural or induced fractures for solution circulation.

Extraction of Minerals From the Leached Zone

True in-situ recovery of shale oil from deep deposits (overburden greater than 500 feet) has had limited testing. Resource recovery from shallow deposits as that of the Geokinetics method has generally been very poor when compared to recoveries obtained by direct mining with surface retorting. The leached zone (a deep deposit), due to its natural permeability, would be amenable to some method true in-situ processing that can take advantage of the natural permeability. The permeability is due in part to the unstable formation conditions that would exclude direct mining and mine assisted in-situ methods.

Combination of Mining Techniques for Different Zones

Of present, the most apparent application of available technologies for recovery of resource beneath either Tract C-11 or C-18 would be as follows:

- The upper two-thirds of the generally competent strata within the Mahogany Zone could be produced using either direct mining, such as underground room-and-pillar, or mine assisted in-situ. Using the room-and-pillar method, one and possible two 40 to 60 foot thick mine levels could be produced recovering up to 50 to 60 percent of the oil shale within the mine levels for a 20 percent overall interval recovery. Mine assisted in-situ could also be used developing virtually the entire thickness of the upper Mahogany Zone through three direct mining levels and in place retorting of the shale between the mine levels. This approach might improve overall recovery to possibly 75 percent of the shale within the area of each rubblized chamber for a 30 percent overall interval recovery.

- The leached zone would generally not be ameanable to direct mining or mine assisted in-situ because of poor broken ground conditions. It might however, be developed by a method in true in-situ where by super heated steam from a pattern of wells, is circulated through the permeable ground caused by solution cavities and brecciation subsequent to natural groundwater dissolution of saline minerals. Currently the efficiencies of the technique are extremely poor.

- The saline zone could be directly mined, produced by some adapted form of modified in-situ, or possible true in-situ. Due to the problems of maintaining accurate borehole alignment, critical to the latter method, borehole length would have to be limited probably necessitating drilling from overlying mine workings. Overall efficiencies of resource recovery would be at the lower limit of those estimated for production of the Mahogany Zone.

Future Technology Development

Research in resource recovery by true in-situ or various combinations of direct mining (stoping and caving techniques) and mine assisted in-situ technologies is continuing at several locations in the Piceance Basin and around the world. Major breakthroughs that will produce higher recoveries at low unit costs appear unlikely in the near future. Mine assisted in-situ, as developed at Occidental's Logan Wash facility, is presently the state-of-the-art in underground processing. Postponing issuance of the subject leases for the short-term (5-10 years) in hopes of a major breakthrough in technology is not warranted. Research and development of mine assisted in-situ technology on the lease tracts in conjunction with direct mining may provide the new mining technology the industry currently needs.

Resources Lost Due To Mining Using Current Technology

An estimated 1 to 2 billion barrels of shale oil may be recoverable from beds at least ten feet thick and averaging 30 gallons per ton on both lease tracts. This is approximately 20 percent of the estimated in place resource of 10 billion barrels per tract.

The recovery of 20 percent of the total resource is based upon a conservative extraction-retorting technology using currently available room-and-pillar and surface retorting technology. Employing mine assisted in-situ, and/or true in-situ methods as well as in combination would result in recoveries possibly as much as 10 percent more than with direct mining alone (see Table IV-5).

These lease tracts contain the thickest sequences of nahcolite/dawsonite bearing oil shale zones in the Piceance Basin. Important oil and gas resources are also located in the area. Untried and unproven mining and processing technologies have the potential of wasting vast quantities of valuable mineral resources. Provisions for concurrent oil and gas development should be included in lease stipulations as well as the requirement for attempted full recovery from both the saline zone (nahcolite/dawsonite/oil shale) and leached zone (R-6, Mahogany).

Impacts of Using Different Technologies on Each Lease Tract

Direct mining by room-and-pillar methods would not cause a significant impact on adjacent lease tracts. Mining (by lease stipulation) may not progress within 100 feet of the lease boundary. Assuming that subsidence is controlled by leaving large pillars and backfilling, there would be no loss of resources outside the mined area. Mine assisted in-situ processing with backfilling as required, results in little or no subsidence. Impacts on offsite mineral resources would not occur. These two mining methods could be used without interference or impact on adjacent lease tracts or on the same lease tract. It also appears possible to use these methods either before or following drilling for oil and gas.

True in-situ processing of minerals in the leached zone could be used taking advantage of naturally created permeability, but would require significant improvement in recovery efficiencies to be economically feasible. True in-situ mining of the saline zone would require extensive fracturing or pre-dissolution of soluble minerals to establish necessary formation permeability and could impact offsite resources if subsidence could not be controlled.

Surface Mine Impacts

Surface mining is economically attractive for large, low-grade or shallow buried deposits because it permits high resource recovery using large, efficient mining equipment. An open pit mine could recover up to 50 to 70 percent of the oil shale in a very thick deposit beneath less than 800 feet of overburden.

Open pit mining was originally planned for Tract C-a. The pit was to have started in the northwest corner of the lease and eventually cover the entire surface. Solid wastes would have had to be initially stored offsite in permanent disposal sites. Off-tract disposal is currently not allowed by the Department of Interior. As a result, the lessee has conducted a program to demonstrate mine assisted in-situ techology for development of the resource. Should offsite disposal be allowed, the lessee would return to open pit development of the tract as open pit mining would enable recovery of better than 5 billion barrels of shale compared to only 1.7 to 2.5 billion barrels from mine assisted processing and surface retorting of the shale.

On the proposed lease tracts overburden is from 900 to 1,200 feet thick. This overburden thickness would preclude surface mining inspite of the apparently favorable stripping ratio. While removing 1,000 feet of overburden to recover 2,000 feet of shale might be possible in theory, the pit's boundaries would be so extensive that it would have to be located on a much larger tract. Furthermore, the large "front-end" investment required to removing overburden years in advance of retorting would probably make open pit mining on these tracts uneconomical. Proposed plans for a "migrating" open pit to move through that portion of the Piceance

TABLE IV-5

ESTIMATED IMPACT ON RESOURCE BASE OF TRACTS C-11 and C-18 (in billions)

Lease Tract	Mined Resource	Estimated in-place Resource	Estimated Recoverable Resource by Mining Method		
			Direct (1)	Mine Assisted In-Situ (2)	True In-Situ (2)
C-11	Shale Oil	9.2 barrels	2.3 barrels	1.6 barrels	.6 barrels
	Nahcolite	3.8 tons	.30 tons	.350 tons	.130 tons
	Dawsonite	.920 tons	.009 tons	.113 tons	.0425 tons
C-18	Shale Oil	10.2 barrels	1.65 barrels	1.1 barrels	.413 barrels
	Nahcolite	4.1 tons	.63 tons	.208 tons	.078 tons
	Dawsonite	1.0 tons	.11 tons	.0827 tons	.031 tons

(1) Estimated recoverable resource data provided by MMS based on room-and-pillar mining with above ground retorting.

(2) Estimated recovery of the resource recoverable by Mine Assisted in-situ and True in-situ methods cannot be substantiated at this time. However these figures have been estimated with the best available data.

TABLE IV-6
CONVERSION OF CROPLANDS TO OTHER USES 1/
PROJECTED FOR 1993 OR FULL PRODUCTION YEAR 2/

Alternative	County	Low Acres	Low % of Total	High Acres	High % of Total
No Action	Rio Blanco	710	1.0	1,070	1.6
	Garfield	3,360	3.4	4,950	5.0
	Mesa: Grand Jct Area	2,700	3.2	4,140	4.9
Total		6,770	2.7	10,160	4.0
C-11	Rio Blanco	310	0.4	400	0.6
	Garfield	510	0.5	640	0.6
	Mesa: Grand Jct Area	90	0.1	110	0.1
Total		910	0.3	1,150	0.5
C-18	Rio Blanco	310	0.4	400	0.6
	Garfield	510	0.5	640	0.6
	Mesa: Grand Jct Area	90	0.1	110	0.1
Total		910	0.3	1,150	0.5
Combined	Rio Blanco	620	0.9	790	1.1
	Garfield	990	1.0	1,280	1.3
	Mesa: Grand Jct Area	200	0.2	220	0.3
Total		1,810	0.7	2,290	0.9

1/ Based on 0.22 acres converted per person increase in population (Dill and Otte, 1971)

2/ Percentages based on worst case situation assuming all urban expansion occurs on cropland.

Basin where the overburden is shallow enough to economically recover oil shale, may not affect the lease tracts.

FLOODPLAINS

Executive Order 11988 requires agencies to avoid, to the extent possible, the long and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct or indirect support of floodplain development whenever there is a practical alternative. If an action must be located on a 100 year floodplain, the order requires minimization of potential harm to people and property and to the natural and beneficial floodplain values. For the purpose of this action, development within the floodplains should be avoided wherever possible, and if unavoidable, impacts must be minimized as stated above. Floodplains associated with the lease tracts are described in Chapter III, Floodplains.

ALLUVIAL VALLEYS

Alluvial valleys may be affected in three ways: 1) groundwater system disruption of water quantity and quality caused by mine development and subsurface retorts, 2) surface disturbing activities such as spent shale disposal placement and topsoil borrow areas for reclamation, and 3) increased sedimentation or erosion. Effects of any mine development and retort scenario upon groundwater contribution to the quality and quantity of water in alluvial valleys is explained in more detail under Chapter IV, Hydrology. Surface disturbances caused to the alluvial valley will be more extensive under the direct mining and surface retort and the mine assisted in-situ methods than the true in-situ method. This is due to the surface disposal and topsoil requirements necessary for spent shale wastes, especially if shale is deposited in valley bottoms.

No Action Alternative

Development of the C-a Tract may impact water availability to the alluvial valley associated with Yellow Creek. No other impacts to alluvial valleys in or adjacent to the tracts are anticipated at this time.

C-11 Alternative

Development of the C-11 Tract could materially damage quality and quantity of water supplied to the alluvial valley of Ryan Gulch and Horse Draw. These valleys are tributary to the Piceance Creek alluvial valley and therefore the quantity and quality of water supplied to the Piceance Creek alluvial valley could also be materially damaged.

Direct damage to alluvial valleys such as burial or displacement, could be significant because alluvial valleys occur on 580 acres (11 percent) of the tract. This could cause interruption of the flow of Ryan Gulch.

C-18 Alternative

Development of the C-18 Tract could materially damage quality and quantity of water supplied to the Yellow Creek alluvial valley.

Direct damage to possible alluvial valleys on the tract is not expected to be significant because only 130 acres (2 percent of the tract) of alluvial valleys occur on the C-18 Tract.

Combined Alternative

Under this alternative, all the impacts discussed above would occur.

Summary

The No Action Alternative would have the least impact on alluvial valleys. The combined alternative has the greatest impact on alluvial valleys. Development of C-11 Tract could materially damage the water supply to the alluvial valleys of Ryan Gulch, Horse Draw and Piceance Creek. Development of C-18 Tract could materially damage the water supply to the alluvial valley of Yellow Creek.

AGRICULTURAL LANDS

On-tract development would impact rangeland which is included under the category of agricultural lands. This impact will not be discussed here, but is included in Chapter IV, Vegetation Types and Grazing.

Some off-tract development such as pipeline routes and utility corridors may temporarily impact agricultural lands (including prime farmlands and irrigated pastureland and hayland of statewide importance). This should not be a significant problem as such lands can be successfully reclaimed within several years.

Permanent impacts to agricultural lands from population growth and the associated conversion of agricultural lands to urban development could be significant. Table IV-6 shows the acres and percentage of land converted from cropland to other uses by county and alternative.

Insignificant impacts should occur to agricultural lands from reduction of surface water flow after implementation of the water augmentation plan as described in Chapter IV, Hydrology.

SOILS

Introduction

The No Action Alternative would have the fewest impacts on the soil resource. The Combined Alternative would have the greatest impact on the soil resource. Development of Tract C-11 could seriously impact the productive potential of the soils on the tract. Development of Tract C-18 could be less impacting to soils than development of the C-11 Tract.

Facility Sites

Facility sites would cause displacement of soil on the site location until these sites are abandoned and removed at end of mine life. Topsoil from surface facility sites would be stockpiled for the life of the mine and lose organic matter, nitrogen, phosphorous, and valuable soil microorganisms (Redente and Cook 1981). Therefore some reduction in soil fertility can be expected. The amount of land committed to facility sites will vary by development technology and alternative (Table IV-7).

Surface Disturbance

Spent Shale Disposal

The direct mining with surface retort technology could be the most impacting to the soil resource. Although the amount of surface disturbance is less than that of true in-situ development, a more radical transformation of the landscape is anticipated because of the large amount of material that must be disposed of on-tract. About 1,000 acres (20 percent of the tract) would be covered with a spoil pile.

Spent shale is not suitable plant growth material because of high salt content, high pH, trace element problems, and a low copper to molybdenum ratio (Dean, Ringrose, Klusman 1979; Redente and Cook 1981; Harbert and Berg 1978; and Stollenwerk and Runnells 1981). Also, the black color (depending on the retort process) of the spent shale can cause the material to absorb large amounts of heat. Temperatures high enough (149°F) to kill roots have been recorded on south facing study plots (Harbert and Berg 1978). Because of these problems, spent shale should be covered with at least 24 inches of suitable plant growth material. On these tracts, less than 15 inches may be available from the disposal site to cover the spent shale pile. Because of material compaction during placement and later settling and erosion of this material, less than eight inches of suitable plant growth material could be available for plant growth at the end of mine life. This would severely limit the establishment of deep rooted plant species. For more details see Chapter III, Surface Reclamation.

Mine assisted in-situ development would require less surface disposal of waste material than for the direct mining technique but the character of impacts would be similar. True in-situ development would not require surface disposal of waste, however this technology would have the greatest amount of surface disturbance requiring reclamation.

Sideslope Soils

Sideslope soils; unit 63, Rentsac series; and unit RT, Torriorthents-Rockoutcrop complex; make up about 3,440 acres or 67 percent of Tract C-11 and 2,820 acres or 55 percent of Tract C-18. Disturbance of these soils would accelerate their already high erosion rates. This acceleration of erosion would last until completion of reclamation. This erosion could cause a permanent reduction in the productive potential of these soils. The relatively steep slopes and broken topography would cause reclamation to be difficult, as discussed in Chapter III, Surface Reclamation.

Bottom Land Soils

Bottom land soils; unit 38, Havre series; unit 41, Glendive series; and unit 75, Barcus series; make

TABLE IV-7
ESTIMATED QUANTITY OF SURFACE DISTURBANCE
BY ALTERNATIVE AND DEVELOPMENT SCENARIO

	Surface Disturbance By Development Scenario (Acres)					
	Direct Mining and 1/ Surface Retorting		Mine Assisted In-Situ		True In-Situ	
Alternative	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary
No Action 2/	--	--	--	--	--	--
C-11	400	1,000	200	1,000	200	3,000
C-18	400	1,000	200	1,000	200	3,000
Combined 3/	Variable: permanent 400-800 acres temporary 2,000-6,000 acres					

1/ Permanent refers to disturbance occuring for life of the mine (e.g. mine facilities, surface retorts) whereas temporary (e.g. spent shale piles, borehole pads) infers short term surface disturbance reclaimable within 10-15 years.

2/ Assumes no additional tract leasing and consequently no further impacts to the existing situation. An estimated 20,000 acres of surface disturbance is expected from current energy activities considered under the No Action Alternative.

3/ The Combined Alternative has nine potential variables. The minimum and maximum disturbance acreages have been calculated to identify the range of potential consequence.

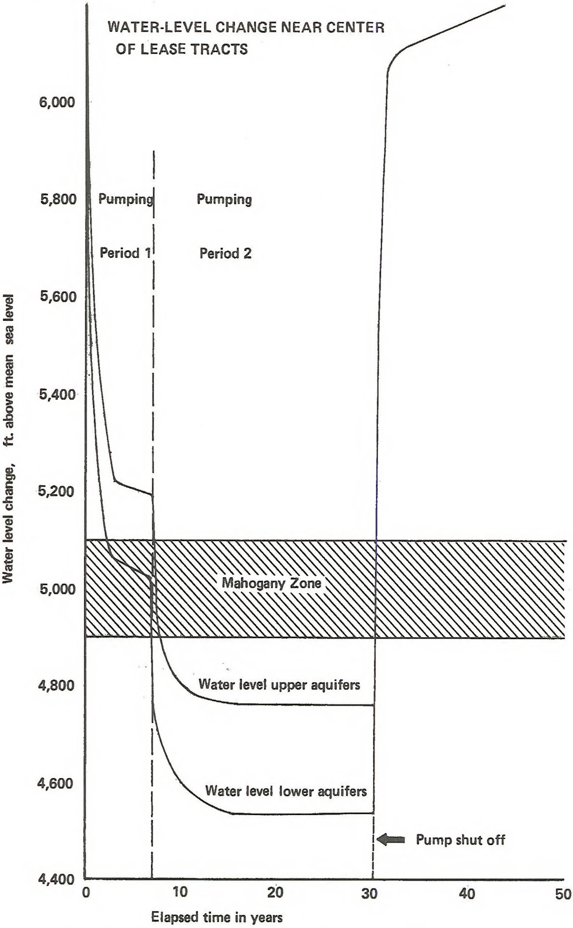


Figure IV-8 Water Level Change Near Center of Lease Tracts

up about 580 acres or 11 percent of Tract C-11 and about 130 acres or 2 percent of Tract C-18. Small scale disturbance of these soils would accelerate their erosion rates, but these rates, except near active gullies and stream channels, are low and this acceleration should not be detrimental if properly controlled. Reclamation should not be difficult unless strongly alkaline subsoil materials are mixed with the upper soil horizons. Large scale disturbance of these soils could interupt the flow of water through them which could change how they function as alluvial valleys (see Chapter IV, Alluvial Valleys).

Upland Soils

Upland soils; unit X63, Rentsac-Piceance Complex; unit 66, Redcreek-Rentsac complex; unit 70, Piceance series; unit 71C, Forelle series; and unit 73 Yamac series; make up about 1,100 acres or 22 percent of C-11 tract and about 2,170 acres or 43 percent of C-18 tract. Units X63 and 66 are shallow and deep and have relatively high erosion rates. The other soils are moderately deep to deep and have relatively low erosion rates. Disturbance would accelerate these erosion rates which could cause some loss of productive potential on the shallow soils units. Reclamation of the other uplands soils should not be difficult because of the relatively high quality of these soils.

Differences Between Alternatives

Under the No Action Alternative, 177 acres would be disturbed on the tracts by development of a sodium mine. Leasing Tract C-11 would be more damaging to the soil resource than leasing C-18 because of the large amount of south facing slopes with shallow and erosive soils on Tract C-11. Tract C-11 also has greater amounts of soils associated with alluvial valleys which are the most productive soils in the Piceance Basin (see Chapter IV, Alluvial Valleys).

HYDROLOGY

Impacts to the hydrologic system were analyzed using established computer models provided by the U.S. Geological Survey (groundwater modeling) and the Bureau of Reclamation (surface water modeling). Baseline information used in these models included the effects of other activities occurring in Piceance Basin upon the water resources, (see Chapter II, No Action Alternative). The models analyzed a worst case development scenario of 100,000 bbls/day, (leasing of both tracts at 50,000 bbls/day each). Impacts for lesser development levels are described as a percentage of the worst case analysis. This section describes the results of the modeling efforts for impacts to groundwater quantity and quality followed by impacts to surface water quantity and quality. Recommended mitigation follows at the end of each of these sections.

Modeling results indicate there could be significant impacts to Piceance Creek, Yellow Creek, and possibly to springs, wells and public water reserves unless reinjection or a water augmentation plan occurs.

Groundwater Quantity

No Action Alternative

The No Action Alternative assumes that mines at both Tracts C-a and C-b will have to be dewatered. It is estimated that long-term pumping rates of 5 and 15 cfs would be necessary to sufficiently lower the potentiometric-head at Tract C-a and C-b respectively, (Robson and Saulnier Jr. 1981). Springs deriving their water supply from the lower aquifer would be affected as a result of the large drawdowns. The impacts to the surface flows resulting from mine dewatering are described in the surface water quantity section.

Development Alternative

Mining of the two proposed lease tracts could have an additional significant impact on the groundwater system of Piceance Basin. There is a considerable amount of groundwater surrounding the minerals which are proposed to be mined. Mine dewatering, regardless of the development scenario or tract leased, will have to take place if the minerals above the Saline Zone are to be mined. Impacts will vary by production rate only, as discussed below.

Groundwater Model

The Water Resources Division of the U.S. Geological Survey was requested to simulate mine dewatering utilizing an existing groundwater model (Taylor 1982). The groundwater model used is a finite-difference computer model with three dimensional flow capabilities (Trescott 1975). The model simulates interactions between adjacent aquifers of differing hydrologic characteristics and also inter-

connections between ground and surface water systems of the area. For the purposes of this analysis, a worst case scenario of leasing both tracts at 50,000 bbls/day production (100,000 total) was analyzed.

Since computer models can only provide estimates, conclusions drawn from this model should be viewed in this light. Mine drainage and dewatering is a complex process and actual rates will only be known when the mine development process begins.

Mine Dewatering

This analysis assumes that groundwater levels in both aquifers would have to be lowered to an elevation of 4800 feet. Dewatering would be accomplished by the use of 15 dewatering wells equally spaced throughout both lease tracts. For the model simulation, wells were completed in the bedrock aquifer below the Mahogany Zone. Over a 30 year pumping period, the simulation wells drained both the upper and lower aquifers which surround the Mahogany Zone.

For the purpose of this study it was assumed that there was a complete hydrologic connection between the bedrock aquifers and Piceance and Yellow Creeks. It was also assumed that Piceance and Yellow Creeks could continue to be depleted even after historical flows were gone.

Mine dewatering was divided into three pumping periods. The first period lasted 7 years and utilized 15 wells pumping at the rate of 2.5 cubic feet per second (cfs) each (27,000 acre feet/year). The second period lasted 23 years and utilized the same 15 wells, but the pumping rates were increased to 3.5 cfs (38,000 acre ft/yr). The third period was a recovery period.

Part of the reason for such large pumping rates is that the potentiometric head of the lower aquifer below the Mahogany Zone at the lease tracts is approximately 1200 feet. The water levels in this artesian aquifer would have to be lowered this distance just to maintain water table conditions at the bottom of the Mahogany Zone. Even larger pumping rates would be required to lower the potentiometric head below this level, so as to be able to mine the R-6 Zone.

A cross section through the middle of the tracts displaying modeled water level changes versus time is shown in Figure IV-8. Water levels for both aquifers declined rapidly during the first two years of pumping and then leveled off after the third year. At the rate of pumpage assumed for period one, 26.5 cfs, the water levels would not be lowered below the Mahogany Zone during the 30 year lease period.

When pumpage rates were increased during the second period, groundwater levels again declined rapidly during the first two years of pumping. The groundwater systems then leveled off at approximately 4780 feet and 4540 feet for the upper and lower aquifers respectively. These levels are below the Mahogany Zone, and are sufficient for mining.

After 30 years the pumps were shut off. At this point the groundwater system was allowed to recover. The recovery rate of the system was nearly back to pre-dewatering conditions after three years.

During period one, approximately 27,000 acre ft/yr of water would be pumped during dewatering. For period two, approximately 38,000 acre ft/yr of water would be taken from the groundwater system. Assuming the high development alternative for both tracts, 16,000 acre ft/yr of water would be required for development. Using the pumping quantities of period two, there would be an excess of 22,000 acre ft/yr of water which would have to be disposed of.

Mine Dewatering With Reinjection Wells

An additional model run was made assuming reinjection of the excess water into the lower aquifer from which it came. Reinjection practices are being conducted on Tracts C-a and C-b. The reinjection wells were located on the perimeter of the lease tracts. The results of this model run indicates that even at the high pumping rate of period two, sufficient dewatering was not attained to dry the proposed mining area. This analysis shows that onsite reinjection of the surplus water is not possible, (using the assumptions and water quantities described in the mine dewatering section).

Off-site reinjection was not examined and is a possible mitigation alternative. Additional study is required for off-site reinjection to determine the best location of reinjection wells from a hydrologic and economic standpoint.

Surface Discharging of Excess Mine Water

Controlled discharge of excess mine water into existing drainages is another possibility for disposal. This is dependent upon the quantity and quality of the mine water. The quantity of excess water which could be discharged into the stream channels would be a function of existing stream flows. The sum of the channel flows plus the discharge of excess dewatering water should not exceed bank full discharge levels below the point of confluence

of the two streams. If bank full conditions are exceeded, increased channel erosion and degradation will occur. Under most mining conditions where surface discharge is occurring increased channel erosion and degredation will occur as evidenced on Tracts C-a and C-b. Excess water may have to be treated depending upon its quality. National Pollutant Discharge Elimination System (NPDES) permits would have to be obtained for this action from the State of Colorado.

Impacts to Existing Sources

Figure IV-9 shows the area in which model simulated groundwater declines would exceed 10 feet. Any springs or wells which derive their water source from the bedrock aquifer system within this zone could be affected by the dewatering. Mitigation for the lost sources could be either by direct replacement or offsite reinjection. The springs and wells located within the area identified in Figure IV-9 would have to be monitored to determine the impacts to the sources caused by mine dewatering.

Mine Development Alternative

Impacts associated with different development alternatives would be less than the high level of development (100,000 bbls/day), addressed by the modeling method. For example, the impacts to the groundwater system caused by mining one tract at a production level of 25,000 bbls/day could be assumed to be one quarter of that of 100,000 bbls/day. This is because only a small portion of the groundwater system would have to be dewatered at the lower level of production.

Effects on Groundwater of Mining the Saline Zone

If mining is to take place only in the saline zone, a shaft could be placed through the upper and lower aquifer and properly sealed with grout and water rings, greatly reducing the amount of dewatering that would be necessary. The resulting shaft drainage would be significantly less than the analysis above and could be pumped to the surface and treated for use in processing. Pilot holes will have to be drilled to test both the quantity and quality of water before dewatering techniques can be developed (Multi Mineral Corp. 1981).

The saline zone (explored at the Bureau of Mines shaft) was found to be a very tight formation, containing very little water. If this case holds, a sufficient layer of this zone would have to be left above the mine to prevent inflow of water from the lower aquifer. If water was allowed to flow into the mine there would be a large increase in the dissolved solids concentrations of that water. Because very little is known about the hydrologic characteristics of the saline zone, it is not possible to quantify hydrologic effects from mining, beyond the above discussion.

Groundwater Quality

No Action Alternative

Under the No Action Alternative dissolved solids concentrations around Tract C-b would remain fairly constant except in the deeper portion of the lower aquifer. Dissolved solids concentractions could be decreased by as much as 1,100 milligrams per liter (mg/l) in the deepest portion of the lower aquifer if the mine was pumped at a rate of 15 cfs, (Robson and Saulnier Jr. 1981).

Dewatering of the mine at Tract C-a would also decrease the dissolved solids concentrations around the mine in the lower aquifer. Decreases of 400 mg/l could occur as a result of downward movement of the upper aquifer water which contains fewer dissolved solids than the lower aquifer water.

Development Alternative

Significant impacts to groundwater quality could occur at the proposed lease tracts as a result of any production rate. Impacts will vary by development scenario only. In-situ retorting associated with either the mine-assisted in-situ or true in-situ scenarios has the potential for creating the greatest impacts (worst case) and will be addressed here. The two principal groundwater quality problems of concern are contamination from leaching of flooded retort chambers and aquifer mixing.

Aquifer Mixing Through Mine Development

Aquifer mixing is the flow of water from one aquifer to another. Mixing of aquifers could be critical in the lease tract area because the lower aquifer has much higher salinity levels than the upper aquifer. Mine dewatering will cause the movement of upper aquifer water into the lower aquifer. Aquifer mixing will also occur after the mining operation has ceased, and the Mahogany Zone has been extracted. By removing this relatively impermeable stratum, water will be allowed to move between the two aquifer systems, a condition that mine void backfilling will not completely mitigate.

Leaching of Subsurface Retort Chambers

Leaching of flooded in-situ retorts could potentially be a more serious problem than aquifer mixing. Because the control of retort process contaminants is more difficult to achieve underground than with surface retorting, leachable organic and inorganic residues would be left in many of the in-situ retorts at the completion of the oil extraction process (Wagner et al 1981). The contaminants which are most likely to increase are pH, Sulphates (SO_4), Sodium (Na), Hydrogen Carbonate (HCO_3), Carbonates (CO_3), and certain organic compounds such as phenols and organic nitrogen compounds which are environmental and public health concerns.

Movement of these pollutants through the groundwater system may take centuries after site abondonment because flow velocities are so low. In-situ leachates carried by groundwater may discharge into Piceance and Yellow Creeks, causing the quality of these streams to approach that of the initial leachate. Studies done on both tracts C-a and C-b indicate that it may take from 100 to 200 years for the leachates from in-situ retorts to reach Piceance and Yellow Creeks, (Fox 1979). Retort leachates from the proposed lease tracts could reach both Piceance and Yellow Creeks in a much shorter time because of their proximity to these creeks.

The groundwater impacts associated with in-situ leachates are highly site specific and vary greatly with local hydrology. Leachate released from a single retort located near tract C-a, once hydrologic equilibrium is reestablished, could continue from one to six years and transport through the lower aquifer would be about 160 ft/yr. If the same retort were located on tract C-b, leachate release could take from 6 to 54 yrs, and transport in the upper aquifer would be at a rate of approximately 20 to 30 ft/yr, (Fox 1979). Additional discussion of potential impacts to groundwater quality resulting from leaching of spent shale piles and subsurface retorts is contained in Chapter III, Surface Reclamation.

Effects of Mine Dewatering

Shaft and mine dewatering could change the direction of groundwater flow in the aquifer systems. The change in flow direction would have an impact on the groundwater system. Simulated mine dewatering conducted on tract C-b indicated that a decrease in dissolved-solids concentration of as much as 1100 milligrams per liter (mg/l) would occur in the deepest part of the lower aquifer (Robson and Saulnier 1981). Downgradient from the mine however, dissolved-solid concentrations would increase by as much as 50 mg/l. Similar impacts are assumed to occur in the vicinity of the proposed lease tracts.

Groundwater Use

Groundwater within the Piceance Basin is presently not extensively used. It does however, support most of the surface stream flows. Most of the existing wells have been developed in the alluvial aquifers. Therefore, short-term groundwater impacts may not be serious. In the long-term, groundwater within the vicinity of the lease tracts may not be suitable for municipal or stock watering without treatment.

Groundwater Mitigation

To reduce impacts to the groundwater system, several mitigating measures could be taken. Proper site selection of the mining area is one of these. Leachate transport would be reduced by isolating the retort within a zone of relatively impermeable strata, (such as the mahogany and saline zone) and leaving a sufficiently thick layer of strata between aquifers. Additional studies need to be conducted to determine the feasibility of this process in the mining operation.

Grouting or filling of a mined area with an insoluble material would minimize seepage of groundwater into the area thus isolating the retort and the resulting leachates. Again, data is very scarce on flooded retorts and mines and their leaching properties. Additional studies are needed to determine the effectiveness of this method.

Another mitigation method which could be considered is back flooding the retort to intentionally leach the spent shale. After leaching has taken place, the leachate would be removed by pumping and treated on the surface. If the above mitigation measures are found feasible and implemented, the impacts to groundwater quality should be minimal.

Statutory regulations which govern groundwater are outlined in the surface water quality section. A new set of regulations governing underground injection have been adopted by EPA and are addressed in 40 CFR Sections 122, 123, and 146. Additional groundwater data is needed in order to determine how these new regulations will affect the groundwater system of the Piceance Basin.

Because of the low rates of flow typical of the groundwater system of the lease tracts, a long-term monitoring program is recommended after retort abandonment. Impacts to the groundwater system may not show up for hundreds of years after abandonment. It is also assumed that monitoring will be

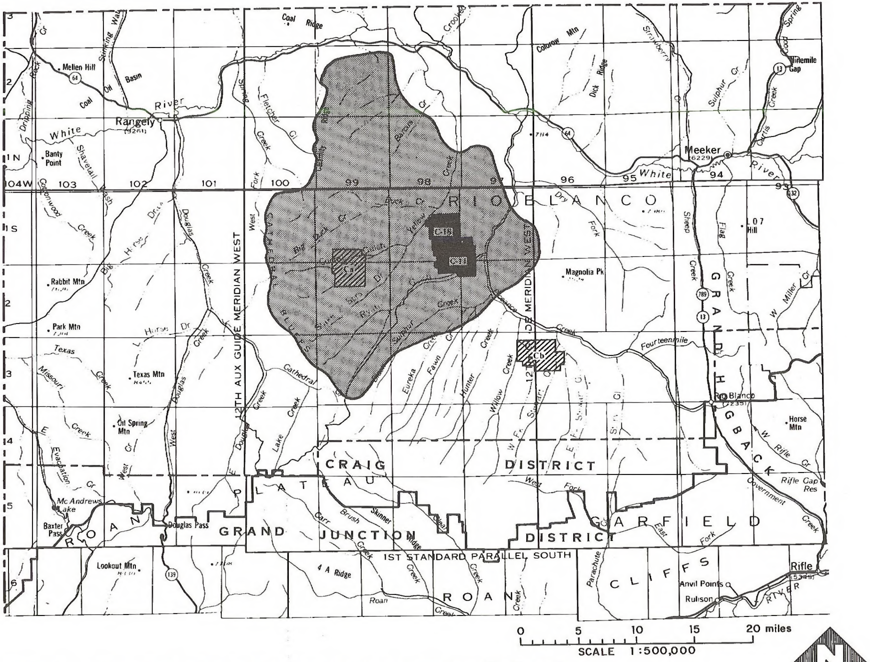


Figure IV-9 Predicted Area Where Lower Aquifer Drawdown is Ten Feet or Greater Due to Mine Dewatering

TABLE IV-8
NO ACTION ALTERNATIVE

CONSUMPTIVE WATER USE FROM
THE WHITE RIVER (ACRE FEET)

Item	1982	1988	1993	2000	2013
C-b	0	6,000	8,000	12,160	12,160
C-a	0	6,000	8,000	16,000	16,000
Other Energy Development 1/	0	7,000	12,000	23,400	27,400
Population Increases 2/	0	1,000	2,000	2,000	2,000
Agricultural Uses 3/	35,000	35,000	35,000	35,000	35,000
Total	35,000	55,000	65,000	88,560	92,560

1/ Includes oil and gas use, sodium, coal and oil shales

2/ Assume 100 gpd/person

3/ Includes existing Agricutural use within the White River basin

conducted during mining as specified in the "Environmental Stipulations" section 9 of the lease.

Surface Water Quantity

No Action Alternative

Assessment of the impacts on surface water under the No Action Alternative are shown in Table III-10. The No Action Alternative assumes that Tracts C-a and C-b would be developed. The depletions to both Yellow and Piceance Creeks were determined by the U.S. Geological Survey, (Robson and Saulnier 1981). Depletions of 18 cubic feet per second (cfs) for Piceance Creek, and 2 cfs for Yellow Creek do not consider reinjection or any other augmentation. Depletions of this nature would cause Piceance Creek to experience periods of no flow during summer months. The flow in Yellow Creek could be reduced by 50 percent after 30 years of dewatering (Rio Blanco March 1976). Yellow Creek currently experiences periods of no flow (see Table III-9 in Chapter III, Hydrology). A reduction of this magnitude would cause Yellow Creek to remain dry over half the time.

Surface Water Modeling

Impacts to surface water on the White River were estimated using the Bureau of Reclamation's Colorado River Simulation System model (Bureau of Reclamation 1981). The modeling runs were developed using hydrologic data based on the 1951 period to simulate a normal cycle. The baseline from which the impacts were developed are outlined in Table IV-8. The Colorado River Simulation model predicted the flows of the White River at the confluence with the Green for production levels of 50,000 and 100,000 bbls/day as shown in Table IV-9.

Impacts to the White River

Development at the 100,000 bbls/day level would cause a reduction in flow of the White River of approximately 4 percent, at the confluence with the Green River. The reduction in flow of the White River associated with development of a 50,000 bbls/day industry would be 2 percent,and a 25,000 bbl/day production would be 1 percent. Reductions in flow of the White River at these levels are considered insignificant. However this water would be lost for other uses, such as agriculture.

These reductions are based upon obtaining all water needs directly from the White River at the rate of 4 barrels of water per barrel of oil shale produced. The numbers do not take into account the varying ratio of barrels of water to barrels of oil which occur according to the type of mining or retort process used, development of groundwater sources, or cognate waters released during retorting.

Impacts to Piceance and Yellow Creeks

Surface water impacts modeled by the U.S. Geological Survey (described in the groundwater section) were based upon the assumption of perfect long-term connection between surface and groundwater systems. The model determined that significant depletions of Yellow and Piceance Creeks could occur and were directly due to mine dewatering. As a worst case analysis the model continued to deplete Piceance and Yellow Creeks even after historical flows were gone.

The predicted surface water depletions for the development of both tracts at either 25,000 and 50,000 bbls/day each or just one tract at 50,000 bbls/day for both Yellow and Piceance Creeks are shown in Table IV-10. Using these model-estimated depletions, Piceance and Yellow Creeks would become intermittent streams flowing only during snow melt or rainfall events.

Figure IV-10 is a graphic example of streamflow depletions through time as predicted by the model. A majority of the streamflow depletions occured during the first seven years when pumping rates were 37.5 cfs (see the groundwater section). The model indicates that groundwater contribution to Yellow and Piceance Creeks would be reduced to zero approximately 3 and 13 years respectively after pumping begins.

One of the primary reasons for such large depletions of the surface water resource is the proximity of the lease tracts to the creeks. The lease tracts are located between the two major drainages of the basin. Tract C-11 encompasses Ryan Gulch, a major tributary to Piceance Creek, and the tract boundaries are within one-half mile of Piceance Creek. Tract C-18 borders Yellow Creek for approximately one mile along the northwest corner.

Surface Water Recovery with Cessation of Mine Dewatering

The model predicted that recovery of the system would occur at a greater rate than depletion. Depletions of groundwater to the streams decreased rapidly for the first two years after dewatering had ceased. The system was almost back to the premining condition 10 years later.

TABLE IV-9
PREDICTED FLOWS AND PERCENT REDUCTION FOR
THREE DIFFERENT PRODUCTION LEVELS OF THE
WHITE RIVER AT THE CONFLUENCE WITH THE GREEN RIVER
(1000 AC-FT/YR)

	No Action	50,000 bpd	100,000 bpd
Baseline 1/	450	450	450
Depletions	0	8	16
Net Flow	450	442	434
Percent Change	0	2	4

1/ Baseline conditions were computed using Bureau of Reclamation's Colorado River Simulation System Model, and include the depletions outlined in Table IV-8. The quantities listed are based on a 29 year average 1984-2013 as computed by the model.

TABLE IV-10
ESTIMATED OF SURFACE WATER DEPLETIONS RESULTING
FROM OIL SHALE DEVELOPMENT IN THE YEAR 2013 IN CFS

	No Action 1/	50,000 bpd	100,000 bpd
Piceance Creek	18	16	27
Yellow Creek	2	12	25

1/ Assumes stream flow depletions as stated in USGS professional paper 1196 (Robson & Saulnier 1981)

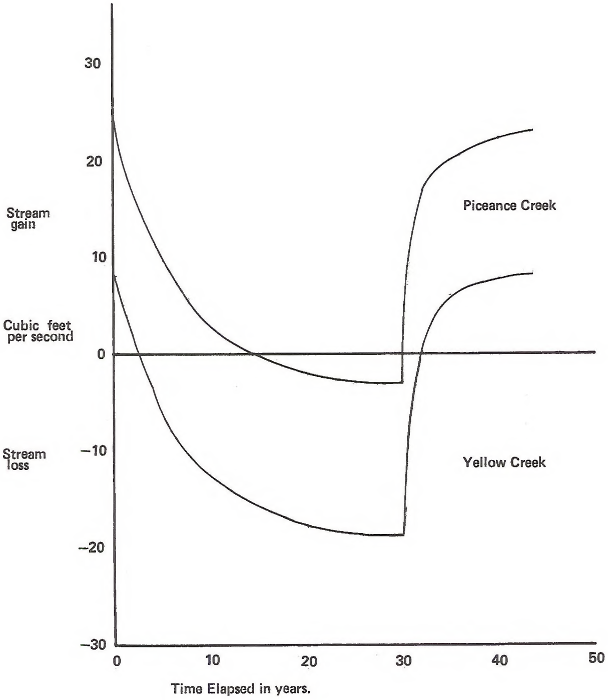


Figure IV-10 Streamflow Depletions Resulting From Simulated Mine Dewatering

Surface Water Mitigation

The potential impacts to both Piceance and Yellow Creeks can be mitigated by either an augmentation plan, purchase of existing water rights, or exchange of water rights. Replacement water can be obtained using a water delivery system from either the White or Colorado Rivers. Water from groundwater sources can be made available to the streams, providing that this water is of similar quality to the water which has been depleted.

Colorado State law protects both surface and groundwater rights holders; thus, one of the mitigating measures described above must be done. Any augmentation plan must be approved by Water Division 5 Water Court, State of Colorado. Monitoring of the surface water within and adjacent to the lease tracts must be conducted for development of an effective augmentation plan.

Surface Water Quality

No Action Alternative

With the No Action Alternative the dissolved solids concentrations in Yellow Creek will increase from approximately 1,100 to 1,900 mg/l in the lower reaches of the creek. The increase in dissolved solids concentrations is a result of a reduction in streamflow attributed to mine dewatering at Tract C-a. The dissolved solids concentrations of Piceance Creek will increase from about 1,100 to 1,400 mg/l in the lower reach of the stream valley as a result of decreased groundwater contributions to the creek, (Robson & Saulnier Jr. 1981). This increase in dissolved solids is due to the loss of higher quality water in the upper stream reaches around Tract C-b resulting from mine dewatering.

Development Alternative

Development of the proposed lease tracts could affect the surface water quality of the area. The potential for water quality problems exists during construction, mining, processing, and disposal of spent and raw shale.

Construction

Construction activities will increase sediment yields regardless of the type of shale retort and mining process used or tracts leased. Because of this, the worst case development of both tracts at 50,000 bbls/day each, will be examined. Lower production rates would have proportionately less impact than this worst case.

During construction of the two tracts, sediment yields would increase by approximately 2-4 acre feet per square mile (Frickel et al 1975). Throughout the construction stage, stream sediment load and siltation could be minimized by contour-grading of disturbed areas, and installation of runoff-retention structures, as stated in the "Environmental Stipulations" section 11 of the lease. If these measures are put into place as soon as possible, impacts associated with sedimentation will be minimal.

Mining

The impacts to the surface water system will primarily be a result of mine dewatering. Decreased flows of the surface water streams will reduce the salinity concentration in the Colorado River. Using the results of the mine dewatering analysis (as outlined in the groundwater section), salt loads delivered to the White River from both Yellow and Piceance Creeks will be reduced by 6,130 tons per year. This salt load reduction is caused by reducing flows from Piceance and Yellow Creeks to the White River by 4,350 acre ft/yr.

Processing

Retort water produced during oil shale processing may have an affect upon the water quality of the area. Retort waters are produced by the combustion of hydrogen and oxygen, and the release of moisture in the shale. These waters contain high levels of many inorganic and organic constituents. Major contituents of retort waters are Ammonia (NH_3), Ammonium salts (NH_4), Hydrogen Carbonates (HCO_3), Carbonates (CO_3), and Sulphates (SO_4). Retort waters are a product of shale retorting. Their composition is highly dependent on the process used.

The quantity of retort waters produced shale retort processing are estimated to range from 0.1 to 22.0 barrels of water per barrel of oil (Fox 1980). Water production is at the lower end for surface processes, and at the upper end for in-situ retorting. The high water production levels resulting from in-situ retorting are due to groundwater inflow and should not be as large if the site is properly dewatered.

Disposal of Spent and Raw Shale

Runoff derived from shale disposal piles may adversely affect surface water quality unless proper measures are taken. Two types of spoil piles are of concern: spent shale and raw oil shale. The quality of leachate and the amount of surface runoff from both types of spoil piles is dependent upon the following factors:

- success of revegetation,
- spoil pile location,
- compaction of the pile,
- the manner in which a spoil pile is laid down,
- the amount of water being added (mean annual precipation or irrigation water),
- particle size of the shale,
- if preleaching occured,
- source of ore,
- process or retorting method used.

Water quality effects may occur during any stage of the disposal operation as a result of climatic conditions.

Leachates from Surface Disposal Piles

Characteristics of leachates from spent shale spoil piles may contain high concentrations of Sodium (Na), Calcium (Ca), Magnesium (Mg), and Sulphate (SO_4). At low concentrations these constituents are not detrimental for many water uses. Some of the minor components in spent shale leachates can be toxic and include Arsenic (As), Lead (Pb), Flouride (F), phenols and organonitrogen compounds. Investigations to properly evaluate the importance of these minor components are presently lacking, (Fox 1980).

The quantity and quality of raw oil shale leachates will be somewhat different from that of spent oil shale leachates. Leachate from raw shale may be in greater volume per unit area and could have similar or even higher levels of total dissolved solids (TDS) and inorganic constituents. The pH, Carbonates (CO_3), Hydrogen Carbonate (HCO_3), and Selenium (Se) contents are not significantly different, (Fox 1980).

Runoff From Surface Disposal Piles

The quantity and quality of runoff is a function of the annual precipitation. The proposed lease tracts are located in an area with a low mean annual precipitation of approximately 13 inches per year and where annual evaporation is greater than annual precipitation. Permeability factors estimated for the Paraho and Tosco processes for various material sizes at maximum applied stress vary from 0.26 ft/yr to 0.48 ft/yr (Bloomfield and Stewart 1981). Based on these low permeability estimates, and low precipitation rates, coupled with the high evaporation rate; percolation of water through the spoil piles may be a controllable problem. However, long-term conditions of precipitation, wetter than normal years, will encourage percolation and leachate transportation.

Mitigation

To minimize the impact of spoil pile leachates on the surface water quality of streams, the following mitigation is specified in the "Environmental Stipulations" section 9 of the lease:

1) Construction of drainage and collection systems below piles

2) Provide lined impoundments between the spoil pile and stream channel

3) Careful placement, compaction and engineering of the spoil piles

4) Careful slope design and conserted revegetation

It may be possible to operate retorts to minimize the dissolved solid concentrations, conductivity and alkalinity of the leachates. This can be done by operation of retorts at temperatures in excess of 800°C. At these temperatures some of the retorted materials react to form, silicates which are relatively insoluble. Another possibility is to preleach the spoils prior to pile formation, and treat the leachate water.

It is recommended that the zero discharge programs adopted by Rio Blanco and Cathedral Bluffs Oil Shale Corporations be adopted for the new lease tracts. Water quality control technologies which have been developed by oil refining industries can be applied to oil shale processing (Crawford et al 1977). Final disposition of waste water should be by evaporation or by incorporation into retorted shale.

Waste waters associated with domestic uses, shall be collected and treated. Treatment effluent can be used for revegetation or to supplement the water required for other processes.

If the above measures are incorporated, pollution of surface and groundwater resources from leachates and contaminated waters should not be a major problem.

Monitoring

Monitoring of surface and groundwater resources (as specified in the "Environmental Stipulations" section 1(c)(2)(a)&(b) of the lease) should be done in order to detect changes related to any of the above mentioned water quality problems.

Statutory Regulations

There are federal and state laws designed to protect the quality of the surface and groundwater of the Piceance Basin. The Federal acts and standards which are applicable are:

1. Federal Water Pollution Control Act (PL 92-500)

2. Surface Mining Control and Reclamation Act (PL 95-87)

3. Resource Conservation and Recovery Act (PL 94-580)

4. Safe Drinking Water Act (PL 93-523)

5. Colorado River Basin Salinity Control Forum Standards

In addition, the State of Colorado has adopted water quality standards and effluent limitations. They include basic standards that apply to all state waters for both surface and groundwater, and additional standards which apply to specific waters. Specific water quality standards which apply to the proposed lease tracts are identified in the Colorado West Area 208 Plan. Colorado has also adopted an "Antidegradation Policy" which applies to both surface and groundwaters. This policy requires that state waters be maintained at existing quality unless it can be demonstrated that a change is necessary.

VEGETATION

Vegetation Types

The types and amounts of vegetation that would be disturbed vary between tracts and according to the mining method used. Table IV-11 summarizes the number of acres of surface disturbance that would occur for each development scenario by range site. This is shown for different uses on each tract (C-11 and C-18). The combined alternative would be the totals for both tracts, which would vary depending upon which development scenarios would be used.

For purposes of this "worst case" analysis, it is assumed that the most productive forage lands would be impacted.

No Action Alternative

Under this alternative up to 20,000 acres in the resource area could be disturbed by coal mining, oil and gas drilling, oil shale development on Tracts C-a and C-b and sodium mining. These disturbances would mostly occur in the pinyon-juniper, sagebrush and mountain shrub vegetative types. These types, however, should not be significantly impacted because these disturbances represent only one percent of the resource area, and the disturbed areas would be reclaimed.

The only impacts on the tracts themselves would be due to the sodium leasing which would disturb a total of 177 acres. This would probably take place in the rolling loam or pinyon-juniper range sites. This impact should not be significant.

Combined Alternative

At the end of the mine life all areas would be reclaimed that had not been completed previously (Oil Shale Lease Environmental Stipulation, Section 11. Rehabilitation). It would take three to four years to reclaim areas disturbed by surface facilities and land leveling, and four to six years to reclaim the waste disposal pile to a grass dominated plant community. A more complete discussion of reclamation is contained in Chapter III, Surface Reclamation.

Returning the chaining to existing conditions or the pinyon-juniper stands to a subclimax community could be done within a few years after reclamation. The return of the rolling loam and foothills swale range sites to a natural community would take approximately 20 years due to the growth of shrubs.

The areas can be reclaimed by either introduced or native species. If they are reclaimed with introduced species, it would take the vegetation longer to return to the native plant community.

In the rolling loam or foothills swale range sites, a return to the natural or climax community would be desired. In the chained areas, a return to the existing conditions may be desired. In the pinyon-juniper sites, a return to a subclimax grassy community or a climax community may be desired.

The waste disposal piles must be covered sufficiently with topsoil in order for them to support a native plant community. If they are not covered, a salt desert shrub community with low productivity may develop. Although returning the land to its ex-

TABLE IV-11
ACRES OF RANGE SITE DISTURBED FOR
DEVELOPMENT ACTIVITIES BY TRACT AND DEVELOPMENT SCENARIO

	Surface Facilities		Waste Disposal		Land Leveling		Totals	
	C-11	C-18	C-11	C-18	C-11	C-18	C-11	C-18
<u>Direct Mining</u>								
Chained pinyon-juniper	400	400	300	100			700	500
Foothills Swale			500	100			500	100
Rolling Loam			200	800			200	800
Total	400	400	1,000	1,000			1,400	1,400
<u>Mine Assisted In-Situ</u>								
Chained pinyon-juniper	200	200	500	300			700	500
Foothills Swale			500	100			500	100
Rolling Loam				600				600
Total	200	200	1,000	1,000			1,200	1,200
<u>True In-Situ</u>								
Chained pinyon-juniper	200	200			500	300	700	500
Foothills Swale					550	100	550	100
Rolling Loam					1,050	1,700	1,050	1,700
Mountain pinyon-juniper					900	800	900	800
Rocky pinyon-juniper						100		100
Total	200	200			3,000	3,000	3,200	3,200

TABLE IV-12
AUMS OF FORAGE IMPACTED BY TRACT AND
DEVELOPMENT SCENARIO

	Surface 1/ Facilities		Waste 2/ Disposal		Land 3/ Leveling		Totals	
	C-11	C-18	C-11	C-18	C-11	C-18	C-11	C-18
No Action 4/	--	--	--	--	--	--	--	--
Direct Mining	100	100	140	125			240	225
Mine Assisted In-Situ	50	50	170	140			220	190
True In-Situ	50	50			375	375	425	425

1/ These AUMs would be lost for the entire life of the mine.

2/ The majority of these AUMs would be lost for the first 15 years of mine life.

3/ These losses in AUMs would occur over the entire life of the mine, however, only 75 AUMs in each tract would be lost at one time.

4/ Assumes no additional tract leasing and consequently no further impacts to the existing situation as discussed under the No Action Alternative.

isting vegetative productivity is committed mitigation, this may be a problem on the C-11 Tract.

While the loss of these acres does not represent a significant loss to vegetation as a whole in the White River Resource Area, it may have a significant impact on the use of vegetation by other resources in the immediate area (see Chapter IV, Wildlife, Grazing and Forestry sections).

C-11 and C-18 Alternatives

The qualitative impacts described in the Combined Alternative narrative section are also applicable to both the C-11 and C-18 alternatives. Table IV-11 differentiates the quantity of range sites disturbed by each development scenario and by alternative.

Threatened and Endangered Plants

None of the alternatives would significantly impact threatened, endangered or rare plants. However, the loss of undiscovered threatened, endangered or sensitive plants population would be a significant impact resulting in the loss of important ecological and biological data. There is a probability of disruption or impact to the three known sites of *Astragalus lutosus* within the tract boundaries. *Astragalus lutosus* is currently under review for possible inclusion in the USFWS list of Threatened and Endangered plant species.

Grazing

Surface disturbance would remove forage available for livestock use. The amount, longevity, and type of surface disturbance resulting from the development scenarios would impact grazing to a variable degree. Table IV-12 summarizes the quantity of AUMs impacted by tract and development scenario based on range site disturbances identified in Table IV-11.

No Action Alternative

Under this alternative, up to 1,500 AUMs of forage could be temporarily lost due to coal mining, oil and gas drilling, oil shale development on Tracts C-a and C-b, and sodium mining. This is only one percent of the AUMs in the White River Resource Area and should not be significant.

Sodium leasing and oil and gas drilling would be the only actions affecting the Square S Allotment. The temporary loss of approximately 15 to 20 AUMs caused by this disturbance should not significantly affect the allotment.

Combined Alternative

The Combined Alternative includes the total impacts that will occur if both tracts are developed. Each tract could have a different development scenario.

The worst case situation for livestock grazing under the Combined Alternative would be direct mining and surface retorting on both tracts. Approximately 465 AUMs representing 11 percent of the allotment's grazing capacity would be affected. This would amount to a loss of approximately 15 days of spring use from pastures B and F (where the operator would be required to obtain forage for livestock elsewhere). This reduction in spring use is important since it occurs when the operator needs to move livestock off his fields and onto the allotment. This is necessary to maintain livestock health and to begin hay production on these fields. A reduction in spring use also conflicts with the AMP objective to continue spring livestock use to improve wildlife habitat conditions. This situation would continue for the first 15 years of mine operation. After 15 years, when a majority of the waste disposal piles are reclaimed, a total of 200 AUMs would remain unavailable in pastures B and F due to surface facility disturbances on the two tracts. This represents a five percent reduction in the allotment's grazing capacity and a loss of six to seven days of spring use from pastures B and F. Under this method, the land should return to its productive potential after the life of the mine.

The minimum impact situation for livestock grazing under the combined leasing alternative would be from true in-situ development on both tracts. A total of approximately 850 AUMs would be affected, however, only 250 AUMs representing six percent of the allotment would be lost at any one time from land leveling and surface facilities. This would result in a loss of approximately eight days of spring use from pastures B and F. After the first 15 years of mine life, the loss of 250 AUMs would be more than compensated for by improved forage conditions due to reclamation and other range improvement practices in the B and F pastures. Under the true in-situ scenario, forage production would probably be increased over the potential productivity levels during the first 30 to 40 years immediately following the life of the mine. This is because pinyon-juniper stands considered too steep and rocky for vegetative manipulation would be reclaimed to a grass dominated site. However, over the long-term (75 to 150 years) these stands would

revert back to pinyon-juniper woodlands and original productive potential.

All three development scenarios would have impacts on certain range projects also. The most important impacts would involve a developed well and pipeline system, and a spring in the B and F pastures, which provide the bulk of the water to these pastures. All development scenarios would lower the water table, thus reducing the amount of water provided by these facilities. These effects would be both short-term and long-term although the water table would probably return 10 or more years after mine shut down. Due to committed mitigation, any water lost from these facilities would have to be replaced from some other source (Oil Shale Lease Stipulations, Section 11, Protection of the Environment: Additional Stipulations; and Section 12, Operations on the Leased Lands: Water Rights).

The only other potentially significant impact to a range improvement would be disturbance to the 1,200 acres of pinyon-juniper chaining on the tracts. However, these would be reclaimed and there should not be a long-term effect. Productive potential of vegetation on this allotment may not be achieved in the short-term as planned due to interference from surface disturbing activities.

C-18 Alternative

The impacts from this alternative would be similar to those of the combined alternative, but quantitatively less. Depending on development scenario, approximately 125 to 225 AUMs of forage could be lost. This is approximately half the impact of the Combined Alternative and 0 to 15 AUMs less than what would be lost under the C-11 Alternative. Spring use on pasture B would be reduced by approximately four to seven days. In the long-term, the potential for increasing AUMs from true in-situ type reclamation would be less than for the Combined Alternative.

The impacts on the well would be less than in the Combined Alternative. Only 500 acres of chaining have the potential for being temporarily disturbed instead of the 1,200 acres under the combined alternative.

C-11 Alternative

The consequences of this alternative would be the same as the C-18 Alternative with the following exceptions. Depending on the development scenario, 125 to 240 AUMs of forage would be lost, or 0 to 15 AUMs more than the C-18 Alternative. Forage and grazing use would be lost from pasture F. Approximately 700 acres of chaining have the potential for being temporarily disturbed instead of the 500 acres under the C-18 Alternative.

Forestry

The primary environmental consequence to pinyon-juniper woodlands resulting from additional oil shale leasing would be the loss of an undetermined number of acres which would be in a nonproductive woodland status for an extended period of time until successful reclamation occurs.

The total number of woodland acres lost will depend on the exact location of developments, including permanent surface facilities, surface waste disposal areas, and land leveling operations.

Under the No Action Alternative, the loss of woodland acres would continue in the present trend due to developments associated with existing oil shale leases, oil and gas activity and support facilities. Pending sodium Preference Right Lease Applications (PRLAs), which are adjacent to or nearby areas under oil shale lease consideration, if approved, would accelerate the loss of woodland acres. The total number of woodland acres lost depends on the exact location and scale of developments.

Due to the slow regeneration and growing characteristics of both pinyon and juniper, the area may not return to a productive status for 100 to 150 years or longer depending upon the proximity of the closest seed source if reforestation is left to natural regeneration. However, if pinyon and juniper seedlings are properly planted at the time of reclamation, the return to a productive woodland status could be accomplished in 50 to 75 years or sooner depending on the quality of the site (Zarr 1977).

The worst case effects on pinyon-juniper woodlands, from the development alternatives are shown in Table IV-13. This table shows the maximum potential losses to pinyon-juniper woodlands by alternative and development scenario. These acreages are considered maximums, actual losses would probably be less since it is unlikely that all surface disturbance would occur on existing pinyon-juniper woodlands.

The true in-situ mining method poses the highest potential losses to woodlands since more surface disturbance would occur. The maximum potential losses from this method involve the majority of woodland acres within each tract boundary.

Such large scale elimination of woodlands would result in long-term changes in the appearance of the landscape. Revegetation of disturbed woodland

TABLE IV-13
MAXIMUM POTENTIAL ACREAGE LOSS TO PINYON-JUNIPER WOODLANDS
BY ALTERNATIVE AND DEVELOPMENT SCENARIO

	Direct Mining and Surface Retorting	Mine Assisted In-Situ	True In-Situ
No Action	---	---	---
C-11	1,400	1,200	2,300
C-18	1,400	1,200	2,500
Combined *	Minimum 2,400	Maximum 4,800	

* The combined alternative has nine potential variables. The minimum and maximum disturbance acreages have been calculated to identify the range of potential occurrence.

TABLE IV-14
ESTIMATES OF REDUCTION IN MULE DEER CARRYING CAPACITY FROM BLM-DOW POPULATION OBJECTIVES IN GMU 22 BY ALTERNATIVE AND DEVELOPMENT SCENARIO

Alternative	Carrying Capacity Decline by Development Scenario (Number)					
	Direct Mining and Surface Retorting		Mine Assisted In-Situ		True In-Situ	
	Low	High	Low	High	Low	High
No Action 1/	--	--	--	--	--	--
C-11	120	168	88	138	150	321
C-18	85	119	63	98	107	228
Combined	Variable from 151-549					

Note: Estimates include habitat destruction and human encroachment impacts. Low estimates are based on assumptions that: (1) a maximum of 200 acres of surface disturbance would occur at any one time, and (2) rehabilitated areas reestablish into productive wildlife habitat within one year. High estimates are based on assumptions that: (1) approximately 60 percent of the total projected disturbance (Table IV-14) would be in an unproductive condition for wildlife at any one time, and (2) rehabilitated areas would require 10 to 15 years for reestablishment into productive wildlife habitat. Human encroachment impacts are based on a 0.1 mile zone around the disturbed areas. Lyon (1979) describes methodology for determining loss of effective habitat.

1/ Assumes no additional tract leasing and consequently no further impacts to the existing situation.

areas would reestablish permanent vegetation of a quality which will support fauna of the same kinds and in the same numbers as those existing before disturbance (Oil Shale Environmental Stipulations, Sections 4 and 11). This is considered to be a difficult task due to the time factor involved in reestablishing pinyon-juniper woodlands.

From a forest resource management point of view, impacts from disturbances resulting from leasing of additional oil shale tracts is not considered serious for any of the designated alternatives or methods of mining. Despite the potential for extensive clearing of pinyon-juniper woodlands, the productivity of these forest lands on both tracts is considered low due to overall inadequate volumes for commercial interest. Therefore, no serious adverse impacts to forest resource management are anticipated.

WILDLIFE

This section has been organized using three major categories: Terrestrial, Aquatic, and Threatened and Endangered Species. Described impacts are applicable to each of the three development alternatives unless addressed as tract-specific. Quantitative estimates have been identified where applicable.

The No Action Alternative would not result in impacts to the wildlife resouce from additional prototype leasing. However, loss of wildlife habitat and animal population declines would continue from ongoing energy development projects. Approximately 36,000 acres of wildlife habitat would be impacted. This correlates to a mule deer carrying capacity or population decline of approximately 2,000 animals. Water requirements for project development would impact aquatic environments and decrease available water for wildlife use and consumption. Increases in local human populations would provide major primary and secondary impacts to the wildlife resource.

Terrestrial

Important adverse impacts to terrestrial animal life occur as a result of (1) on-tract physical destruction or alteration of habitat, (2) human encroachment on habitat, (3) direct mortality to wildlife, and (4) secondary off-tract impacts. These impacts will be discussed separately below.

On-Tract Physical Destruction or Alteration of Habitat

The physical destruction or alteration of habitat particularly from large-scale operations is one of the most crucial impacts to the wildlife resource. Habitat destruction or alteration occurs mainly during road construction activities, establishment of surface mine facilities, development of overburden and spent shale piles, construction of product transportation systems, and placement of utility corridors.

The estimated quantity of habitat destroyed or altered for each alternative and development scenario is summarized in Table IV-7. Duration of habitat disturbance is variable and can be separated into permanent and temporary categories. Permanent indicates that the habitat would be disturbed for the entire mine life and would not be available for wildlife use until reclaimed after mine shut down (e.g., surface mine facilities). Temporary disturbances would be reclaimed within a shorter time period and prior to mine abandonment (e.g., pipeline corridors, spent shale piles).

Disturbance of terrestrial habitat reduces the quantity of vegetation available for wildlife consumption. Forage loss would be most deleterious to mule deer since preferred deciduous shrub production is considered a limiting factor regulating herd size in Piceance Basin. Projected declines in mule deer carrying capacity from loss of terrestrial habitat for each alternative and development scenario are presented in Tables IV-14 and IV-15.

Cover utilized by wildlife for reproduction, escape and protection from adverse weather conditions would also be destroyed. Pinyon-juniper provides thermal cover to mule deer during inclement weather. Pinyon-juniper cover on this portion of winter range is important since the highest deer concentrations are present on these areas during periods of most severe weather conditions.

A potential impact of presently undetermined importance is the intake of trace metals by ruminent herbivores in vegetation growing on processed shale. The consumption of molybdenum is the main potential problem. It has been shown that cattle can acquire molybdenosis if the right combination of copper, sulfates, and molybdenum are injested over a period of time. The effect on deer is essentially unknown.

Present reclamation technology is unproven or inadequate in several categories when replacing wildlife habitat of similar type which is equal in quantity and quality to that destroyed or damaged. Methodology for revegetating spent shale piles on a large scale basis is in the speculative phase. Sur-

face disturbance has been successfully revegetated in the short-term with grass and forbs, but to a lesser degree with preferred browse species and pinyon-juniper cover. Establishment of grass and forbs can increase site productivity and provide additional forage for big game use during spring and fall seasons. However, this forage becomes unavailable during the winter when sufficient snow accumulation occurs. Successful establishment of browse stands may require 10 to 20 years after initial planting. Seventy-five to 150 years may be required before reestablishment of pinyon-juniper to conditions where adequate winter cover is provided.

Reclamation of disturbed sites replaces vegetation, but would not adequately compensate entirely for the forage production lost over the period of disturbance. Implementation of habitat improvement projects in addition to site reclamation is necessary to mitigate forage loss and maintain present carrying capacities of the habitat for wildlife use. Vegetation monitoring is necessary to ensure that forage production of equal quantity and quality is achieved from mitigation efforts.

Human Encroachment On Habitat

The effects of human encroachment on wildlife are variable depending on the type and quantity of encroachment, the tolerance of a species to encroachment, and the time of year.

A significant increase in vehicular traffic is necessary to transport mineral products and employees (see Chapter IV, Transportation). On-tract development and improvement of road systems would increase local disturbance to wildlife. Intense disturbance from construction activities would also affect wildlife.

If on-tract housing is permitted, additional intensive levels of encroachment would impact the wildlife resource. This would especially be true if no after-hours restrictions are placed on residents. Such encroachment would occur from employees who participate in outdoor recreational activities such as four-wheel driving and snowmobiling, and greatly increases the number and opportunity for people/wildlife encounters. Illegal camping of temporary or short-term employees would promote similar adverse impacts.

Wildlife species respond differently to human disturbance. Disturbance- tolerant species such as passerine birds, mourning dove and cottontail would probably adjust to increased encroachment and would not be significantly impacted. Disturbance-intolerant species such as mountain lion and elk would not adjust and would disperse from the tracts into adjacent, less-impacted habitats.

The season of year when disturbance occurs would also influence wildlife response to encroachment. Raptors tolerate human encroachment to a certain degree except during territorial establishment and egg laying periods of nesting. The golden eagle nest on Tract C-11 would possibly be abandoned if additional encroachment occurs along County Road 24. The seasonal use stipulations and area of no surface occupancy would minimize adverse impacts to this nest from mine associated activities. Mine related activity in close proximity to undiscovered raptor nests, particularly the tree nesting accipiters and owls, would prove detrimental to local raptor productivity and populations. This could be an impact of major concern since two of the accipiter species found here, the sharp-shinned hawk and Cooper's hawk, are on the American Birds Blue List. Species on this list exhibit indications of non-cyclical population declines or range contractions, either locally or on a widespread basis.

On these tracts, the winter season would be the most critical time of year for harmful impacts to mule deer from encroachment. Encounters with people can be a serious matter when deer are concentrated in areas of marginal cover, under physiological stress because of poor forage nutrient content and/or harsh weather, and restricted in mobility by deep snow. The seasonal restriction stipulation, to protect big game critical winter ranges, would be applied as warranted to reduce this impact. It would not eliminate this impact, but would minimize it where management actions apply.

Deer could acclimate to consistent and regular encroachment. However, inconsistent encroachment would affect deer by changing animal behavior, distribution of animals and animal welfare. Mule deer behavior would change when encroachment would prevent traditional unrestricted use of prime feeding, bedding or watering areas. For example, if encroachment from operation of mine facilities occurs only during daylight hours in a prime feeding area, deer may wait until dark to forage there. Displacement of wildlife would occur if encroachment levels exceed their specific tolerance levels or prevent adequate use of crucial portions of the habitat. Animal welfare would be impaired if behavior changes or animal displacement force wildlife to inhabit areas of lesser quality. Animal displacement would concentrate animals together causing local overuse of forage.

Rost and Bailey (1979) and Lyon (1979) both concluded that habitat effectiveness for deer and elk is significantly reduced when an increase in human disturbance occurs. The decline in habitat effectiveness depends upon quantity and location of disturbance, topography, and availability of ade-

quate escape cover. A 0.1 mile buffer zone surrounding the area of surface disturbance was established to determine the size of area impacted and to estimate the number of animals affected. This estimate was added to the predicted animal loss from direct surface disturbance to quantify mule deer impacts.

Effects on the two mule deer seasonal migration routes is presently unknown because the location of facilities is undetermined. Facility placement within or adjacent to the migration routes would not terminate migratory use of the area, but would probably force deer to use adjacent areas of less disturbance.

Wild horses would probably be displaced from their present location to the northeast corner of the Square S Allotment. They would likely remain in this pasture pending availability of adequate water supplies. Inadequate water supplies would force horses onto the North Dry Fork Allotment. Management conflicts would arise since forage has not been allocated for wild horse use on this allotment and would result in adverse impacts to vegetation condition, and present authorized use by livestock and wildlife.

Direct Mortality to Wildlife

During construction, small mammals and reptiles of limited mobility would be killed. Loss of these prey species, in turn, may impact dependent predator species.

A significant increase in traffic volume correlates to an equal increase in the number of vehicle/wildlife accidents. Direct mortality from road kills would occur to many wildlife species, but would most seriously affect mule deer. Analysis of road kill information collected by personnel from C-b Tract along the Piceance Creek Road (Rio Blanco County Road 5) indicates vehicle-related deer kills fluctuate annually. The periods of greatest road kill frequency correspond to migratory movement, and the use of roadside forage and hay meadows. This period extends from mid-October to late-November and early-February to late-April. From 1977 to 1981, 435 road kills were counted along County Road 5. This count does not include road kills on Highways 13 and 64. C-b Tract data collected during 1980 and 1981 indicates an average of 7.65 deer killed per 10,000 vehicles on the Piceance Creek Road.

Table IV-16 summarizes the estimated increase in vehicle-related deer kills from increases in traffic associated with the various alternatives and development scenarios.

The relationship of the mining work force to poaching rates has been clearly demonstrated in northwestern Colorado. Numerous sources report incidents of energy workers shooting deer and other wildlife indiscriminately enroute to and from work. This unquantifiable impact is compounded in areas where field work coincides with periods when wildlife are most active (e.g., dawn and dusk). Establishment of a busing program to transport employees to and from work would reduce the quantity of road kills and poaching incidents.

Secondary Off-Tract Impacts

The intensity of secondary impacts is directly proportional to population increases in local communities. Chapter III, Social identifies and describes projected population increases by alternative and development scenario.

Population increases would result in land consumption (and accompanying habitat destruction) for residential, commercial and community (public facilities and services) development. Table IV-6 estimates the acreage of cropland affected by urban expansion and also applies to the quantity of wildlife habitat destroyed by alternative and development scenario. An increased number of domestic animals, especially dogs and cats, commonly accompanies this community growth and would result in direct adverse impacts on wildlife populations and distribution.

Surveys of construction personnel indicate their preference for outdoor recreational activities (see Chapter IV, Recreation). This correlates to a substantial increase in hunting, fishing, poaching and other recreation-related disturbances to wildlife. Of particular importance is snowmobile use on big game winter range; and ORV use, backpacking and camping on mule deer and elk summer ranges.

Increases in consumptive use of wildlife would force the Colorado Division of Wildlife to alter future game and fish management strategies. Adjustments in bag limits, length of seasons and/or number of sportsmen participating would be necessary to prevent over-harvest.

Aquatic

Water quality and quantity impacts have been described in Chapter IV, Hydrology. It is assumed that a water augmentation plan (Environmental Stipulations of the Lease Section 9 Pollution--Water) would be developed to mitigate water quality and quantity impacts in Yellow and Piceance Creek. If successfully implemented, this would result in insignificant impacts to stream productivity, fisheries,

TABLE IV-15

MATRIX SUMMARIZING ESTIMATED REDUCTION IN MULE DEER CARRYING CAPACITY FOR VARIOUS LEASING COMBINATIONS UNDER THE COMBINED ALTERNATIVE

C-18 Alternative	C-11 Alternative					
	Direct Mining		Mine Assisted In-Situ		True In-Situ	
	Low	High	Low	High	Low	High
Direct Mining	205	287	173	257	235	440
Mine Assisted In-Situ	183	266	151	236	213	419
True In-Situ	227	396	195	366	257	549

Note: Footnotes from Table IV-14 are identical and applicable here too.

TABLE IV-16

ESTIMATED ANNUAL INCREASE IN VEHICLE-RELATED DEER KILLS 1/

Alternative	Estimated Potential Number of Deer Killed 2/			
	1988		1993	
	Low	High	Low	High
No Action 3/	--	--	--	--
C-11	207	287	608	1,113
C-18	111	201	462	969
Combined	318	488	1,070	2,082

1/ Projections based on estimated traffic increase and existing Piceance Creek road kill information.

2/ 1988 = Peak Construction Year, 1993 = Full Production Year, Low = 25,000 bbls/day production, High = 50,000 bbls/day production

3/ Assumes no additional tract leasing and consequently no further impacts to the existing situation.

TABLE IV-17
CULTURAL RESOURCES WHICH COULD BE IMPACTED
BY ALTERNATIVE AND DEVELOPMENT SCENARIO

Alternative	Direct Mining And Surface Retorting	Mine Assisted In-Situ	True In-Situ
No Action	None	None	None
C-11	8.6	8.6	25.9
C-18	16.7	16.7	50.0
Combined	23.3	23.3	69.8

waterfowl, wildlife consumptive use and animal distribution.

Any spring or well flow depletions within the affected area would reduce water quantity available for animal consumption; affect animal distribution (especially important on spring-summer-fall deer range); reduce available riparian vegetation; and affect riparian-dependent wildlife species.

Threatened and Endangered Species (T/E)

A biological assessment submitted to the U.S. Fish and Wildlife Service (USFWS) concluded that no anticipated adverse impacts directly attributed to prototype oil shale leasing and development would occur to the black-footed ferret, whooping crane and peregine falcon populations or habitat. No direct impact to bald eagle winter or migratory populations should occur as a result of this project. Adverse impacts could result as additional bald eagle/human interactions occur, and anticipated unquantified mule deer population declines reduce the total available carrion base. BLM has requested USFWS assistance in assessing whether or not anticipated water uses would have significant effects on the White River and T/E fish habitat. The pending USFWS biological opinion will determine the accuracy of BLM's impact assessment.

CULTURAL RESOURCES

The BLM has contracted for a cultural resource study in the Piceance Basin to generate data of area-wide suitability for planning the proposed oil shale development. This study, to be completed in September 1982, will analyze known site distribution and location data, existing artifact collections and areas surveyed for representiveness of the oil shale area. A predictive model of sites types, location and distribution will then be constructed and field tested for accuracy (Newkirk et al March 1982). Until this predictive model is completed, existing survey data will be utilized to assess potential environmental consequences to cultural resources.

Direct impacts to both archaeological and historical resources could result from surface disturbing activity. Under the No Action Alternative, Multi Mineral's sodium mine, which includes portions of tract C-18, would create surface disturbance of up to 177 acres. Since it is not known how much of the actual surface disturbance would be within the C-18 boundary, it is not possible to give an exact figure of cultural sites which could be disturbed but some disturbance can be anticipated.

Surface disturbance and consequently, impacts to cultural sites increase with the leasing of additional tracts for prototype oil shale development. Since both tracts are of equal size, disturbance would be governed by method of development. Table IV-17 shows the number of sites which could be impacted by tract and development method used. Anticipated cultural resources per square acre figures have been developed from existing survey data on file in the White River Resource Area, BLM (Conner and Langdon January 1981 and Weber et al April 1977). Since this in only predictive, no estimate of the significance of these sites can be made.

Existing data for cultural resources shows that site density on Tract C-11 is lower than that recorded for Tract C-18. Either direct mining and surface retorting or mine assisted in-situ development would have the lowest amount of surface disturbance. Therefore, either of these development scenarios used on tract C-11 would have the least amount of adverse impacts on cultural resources. True in-situ development on Tract C-18 would have the greatest impact. Subsidence could result in delayed impacts to cultural resources.

Indirect impacts to cultural resources could also occur. Although vandalism cannot be directly related to the alternatives, it can be considered an indirect adverse impact. Increased access by energy personnel, construction crews and the general public could add to the amount of damage which could be done to archaeological and historic sites.

PALEONTOLOGY

Adverse Impacts

During the construction phase, earth disturbing activities could damage or destroy both vertebrate and invertebrate fossils, whose quality, quantity, and significance have been discussed in Chapter III. The direct access by construction/mining personnel and visitors to the fossil resources could lead to fossils being vandalized or illegally removed. Monitoring to control possible theft or vandalism would be difficult.

Surface disturbing activities could also cause an increased erosion rate which would increase the rate of weathering damage to the fossils.

Beneficial Effects

Some fossils could be unearthed, undamaged during surface disturbing activities, which would otherwise have gone unnoticed. Salvaging these fossils would increase our knowledge and understanding of them and their environment. However, unmonitored collecting of fossils by the nonscientific community over a period of time would result in a significant loss of research and exhibit material.

VISUAL RESOURCES

Visual resources in the White River Resource Area are managed to minimize the impacts of development in those lands that have outstanding scenic quality ("A" Quality Scenic Rating) and/or a high visual sensitivity (A or B quality viewed within a quarter-mile of any major transportation route).

All of Tract C-18 is rated as minimal scenic quality ("C" Quality), the lowest rating given by the BLM, therefore the scenic quality would not be reduced, no matter what the development. Also, all of C-18 is rated as only moderate sensitivity. No matter what degree of contrast would be created with the current landscape by man-made developments the effect is considered to be insignificant due to the relatively low quality and viewing sensitivity.

Most of Tract C-11 is identical to C-18. It is mostly minimal scenic quality, except for Ryan Gulch, which is rated as characteristic ("B" Quality) scenic quality. The visual sensitivity, like C-18, is mostly moderate, except for the extreme southeast corner which is rated as low. If any of the oil shale development were to be placed in Ryan Gulch it could lower the scenic quality rating to "C" Quality. However, no matter what degree of contrast that may be created with the current landscape by man-made developments, the effect is considered to be insignificant due to the relatively low quality and viewing sensitivity.

In summary, while the "development" alternatives would all result in large degrees of contrast with the natural landscapes of the proposed tract sites, none of these alternatives would result in significant impacts due to the relatively low scenic qualities and viewing sensitivities of the areas.

RECREATION

All of the development alternatives would have some adverse effects upon the hunting use of the tract sites, due to direct disturbances by the oil shale operations. In addition, all four of the alternatives (including the No Action Alternative to a lesser degree) would result in some adverse effects to the hunting use of the Piceance Wildlife Unit (22), due to an increased local population. However, the overall effects upon opportunities for outdoor recreation would be small.

Direct Impacts

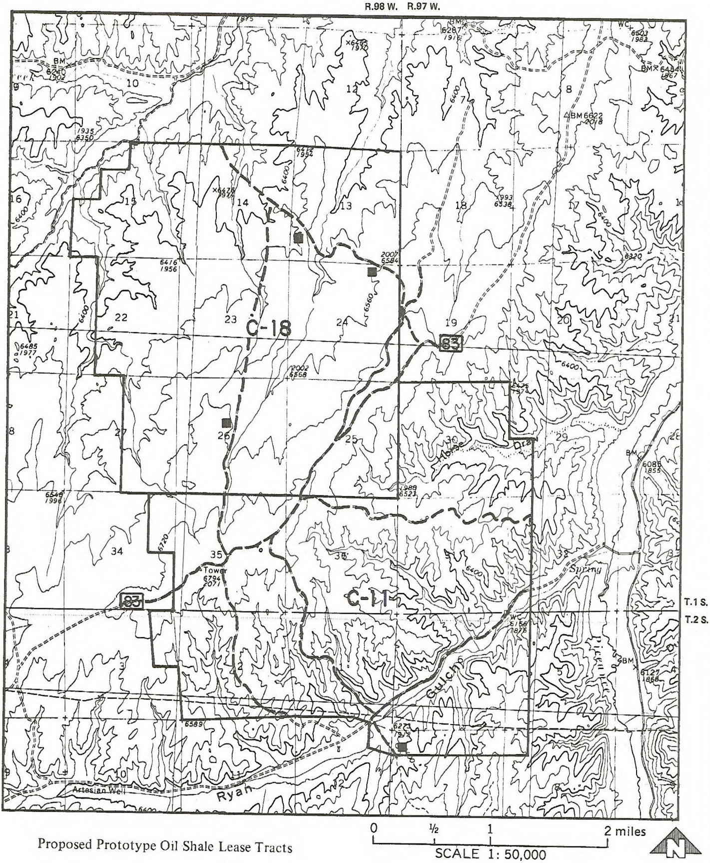
The direct effects, caused by construction and operations, include: land disturbance, noise, game habitat loss, increased traffic on previously little traveled roads, construction of new roads, displacement of both game animals and hunters, and an aesthetic depreciation of the immediate area.

Hunter use on the proposed tract sites cannot be quantified. However, it is known that the roads on these sites are used extensively by hunters during the appropriate seasons (see Figure IV-11). If any of the roads were closed due to oil shale activity, it would deny access to hunters. All six of the BLM roads on the two tracts are mainly limited access type of roads. The Yellow Creek Jeep Trail (Rio Blanco County Road 83) is a primary access road and denial of this route to hunters would be a significant impact.

The fact that mule deer and cottontails (the primary game species) would be displaced from the immediate area (see Chapter IV, Wildlife), would be another reason for a decline in hunting opportunities, *in the immediate area of the tract sites*. However, the effects on hunting opportunities in the Piceance Wildlife Unit would be relatively unnoticeable as a whole.

The addition of man-made structures, noise and traffic on the tracts could adversely affect the hunting opportunities in the immediate area. For example, studies have measured the satisfaction derived by deer hunters and found that the three strongest enhancing factors were, in order: naturalness, solitude and marksmanship. Oil shale development would conflict with the first two factors significantly.

The direct impacts to outdoor recreation use (hunting) would be most severe if the combined alternative is implemented; next most severe if C-18 is chosen, due to its estimated slightly larger degree of hunting use; and thirdly, the effects of



Proposed Prototype Oil Shale Lease Tracts

Hunter Roads

Hunter Camps

Figure IV-11 Recreation. Hunter Access and Hunter Camps

TABLE IV-18

SOCIAL IMPACTS: PORTRAIT OF A BOOMTOWN*

A. Social Structure	Formaliziation	Power/ Influence	Personnel/Facilities Short term	Personnel/Facilities Long term	Defined *** as Social Problem
Political	Occurs **	Longtimers - Newcomers +	-	+	
Economic	Occurs	Longtimers - Newcomers +	-	+	
Educational	Occurs	N/A	-	+	
Control/Safety	Occurs	+	-	+	Yes
Religious	Occurs	-	-	+	
Recreational	Occurs	N/A	-	+	Yes
Health-Physical	Occurs	+	-	+	Yes
Health-Mental	Occurs	+	-	+	Yes
Social Services	Occurs	+	-	+	Yes

B. Social Groups	Power	Well Being: Physical	Well Being: Economic	Well Being: Psychological	Interaction Opportunities	Economic Opportunities	Defined as Social Problem
Elderly	-	+	+ -	+ -	+ -	N/A	Yes
Youth	N/A	+ -	+	+ -	+	+	Yes
Women							
Short term	-	+ -	+ -	-	+ -	+ -	Yes
Long term	+	+ -	+ -	-	+ -	+	
Men	+	+	+	+ -	+	+	
Ranchers	-	0	+ -	+ -	+ -	+ -	

C. Social/Physical Conditions	Short Term	Long Term	Defined as Social Problem
Housing	-	0	(short term) Yes
Noise/Dirt	-	+ -	Yes
Traffic	-	-	Yes
Unemployment	+ (would decrease)	+ -	
Living Costs	+ -	+ -	(short term) Yes
Quality of Life	+ - 0	+ - 0	

D. Attitudes/Values	Short term	Long term
Energy	+ -	+ 0
BLM	+ -	+ -
Local Traditions	-	-
"World View"	+	+
Liberalism	+	+
Community Changes	-	+ -

* This table is an attempt to summarize existing literature on what happens to a town in an energy boom

** See text for explanation

*** A social situation only becomes a "social problem" when persons identify it as such. There is public recognition of a need for solutions to these problems but not necessarily agreement on what solutions should be.

+ Positive Impact - Negative Impact 0 No Change N/A Not Applicable

+ - Positive for some persons/groups, or under some conditions; negative for other persons/groups, or under some other condition

developing C-11. The effects on recreation would be even less from choosing the No Action Alternative.

The mining methods would all have a similar adverse effect on recreation. Even though one may disturb more acreage than another, the overall presence of any of these operations would discourage hunting use near them.

The indirect effects of leasing one or both of these tracts on the hunting use, involves the expected increase in local human populations, especially the influx of a large blue collar population. Surveys of construction and permanent oil workers indicated their most popular recreational activities are fishing, hunting and camping, with lower priority given to indoor activities and spectator sports.

Any human population increase is accompanied by additional hunting pressure. The decided preference of energy-related blue collar workers for this form of recreation causes an additional increase beyond what would normally be expected for that increase in population. In the Gillette, Wyoming coal mining area, for example, the mean number of recreation days per day of hunting season increased over 240 percent from 1971 to 1977 for antelope hunting and by 143 percent for mule deer hunting. During this same period, the human population increased by only 112 percent for Gillette County (Wyoming Big Game Harvest, Wyoming Game and Fish Department 1979).

If a similar situation occured in this region, the hunter success ratio could adversely change, thus affecting the hunting quality. At that time, the Colorado Division of Wildlife would probably implement a permit system. While this action would restore the quality of the hunting opportunities by limiting the number of hunters, it consequently limits the number of recreational opportunities as demand escalates.

It is impossible to predict the degree of impacts with any accuracy because the Division of Wildlife has no thresholds established for either hunter-density or hunter-success, and because percentage of new hunters to new employees is unpredictable. In addition, the Division of Wildlife does not know where, within the State, hunters that utilize Unit 22 come from.

The indirect impacts of population growth on outdoor recreation opportunities would be more severe the larger the operation(s) due to employment increases. For example, the most impacts would obviously come from the Combined Alternative, as this would create the most employment. The least impacts would result from the No Action Alternative, as the population would increase only 38 percent, versus the 59 percent increase with both tracts, due to other growth in the region. Population effects on recreation would be identical from either the C-18 or C-11 alternatives. The effects of employment on outdoor recreation would also be maximized during the peak construction year of 1988.

Overall, the most significant impact to recreation resulting from the development alternatives would be the possible blockage of hunter access on the Yellow Creek Jeep Trail (County Road 83). The other impacts listed above are estimated to be insignificant, in and of themselves, but add to the cumulative impacts of other developments in the area which increasingly diminish both the quality and quantity of recreation opportunities in this region over time.

SOCIAL

Boom Town Social Patterns And Processes, And Their Interaction With Energy Employment Sequences

The social impacts of energy development on communities are similar because the employment patterns underlying them are similar. The severity of impacts and the signficance of the various components impacted will vary depending upon three sets of factors having to do with characteristics of the present and incoming population, growth rate, and the size and history of the impacted communities, as described in Chapter III, not enough data exist to quantify these predictions.

In this section we shall discuss first the general form of social impact patterns (Table IV-18); and, second, the interactions of these with employment sequences (Figures IV-12 to IV-15). The following section will use these discusions to describe and predict the specific social impacts for the seven communities (Tables IV-19 and IV-20); and the last section will cover effects upon the quality of life.

The employment pattern consists of a three-pronged segment as shown in Figure IV-12. Construction workers enter in large numbers over a short period of time, followed later by operations workers (miners, etc.). Population increases due to these draw a third group, secondary (non-basic) workers salespeople, waitresses, equipment dealers, social workers, etc.

Construction requires many specialized blue collar skills (carpenters, electricians, pipefitters, plumbers) temporarily, and as the various phases start and finish their transiency causes fluctuations

in the population curve (wavy line in Figure IV-12), and an accompanying social disruption in the community. Many problems come to be defined by the community (last column, Table IV-18) because in this stage the community (especially if small, stable and isolated) may be unprepared structurally and psychologically, and facilities and services have not been expanded, to meet the demands of increasing population.

Table IV-18 is a general summary of the literature on boom town social impact processes as they affect various social components. Together the items shown represent a graphic picture of an energy boom town. For instance, the fourth element of Part A, Social Control and Safety, shows that the structure of law enforcement, which is responsible for these, will undergo formalization (better equipment, more formal procedures, more professionally trained personnel will replace less "scientific" equipment, informal procedures, less well trained personnel); that the influence of the police, sheriff, etc, departments in the community will increase; that at first need will outstrip supply of personnel and equipment (short-term negative) but that in the long run law enforcement services will have improved through these changes (long-term positive).

The interested reader is urged to consider each element line of Table IV-18 for its implications, in order to track the boom change processes.

Some social problems are created because long-time residents tend to develop negative stereotypes of particularly the construction workers. These local perceptions and the behavior they produce are usually more negative than real differences would imply. The best evidence (see Green River/Hams Fork Final EIS, p. 108) indicates in fact that most incoming workers are from within the region itself (so are not very different). Most construction workers, especially if married, apparently remain as long as work is available, going from job to job within the area, sometimes commuting some distance in order to keep their families in one spot.

Some differences, however, are socially important: construction workers do tend to be younger, more often transient and single, and come on the scene before a commmunity is able or willing to receive them. They will place somewhat different demands upon the community than will more settled older workers because they have fewer ties and less commitment to it. They are often lonely, with no social bonds, and will be more apt to frequent the bars in spare time to find companionship. Some communities will respond by trying to close ranks to exclude them in much the same way and for much the same reasons communities near military bases may close ranks against a large influx of anonymous, temporary young recruits. Construction workers have little real threat or even effect upon most community social structures, but are likely to be perceived as threats to the safety and stability of the community because of the negative stereotypes noted.

Most operations workers are also blue collar but their social impacts are different. High wages, permanency, and the presence of families provide them with more ways of becoming a part of the community. They arrive after the community has made some social and economic adjustments and are less conspicuous and therefore less threatening. They affect such social institutions as schools, churches, civic and government organizations. Finally, secondary workers differ little, if any, from the existing population.

The "boom" period for social impacts is shown in Figure IV-12 as the shaded lag time between construction and non-basic employment. See Green River/Hams Fork Final EIS, p. 220, for further discussion of boom impacts. If operations workers are much fewer in number than the construction force, as will be the case here, the boom will close with some slump in population (about 1990 to 1993 as shown in Figure IV-12) requiring downward adjustments in services, housing, etc., followed finally by a new stabilization at a population larger than the original but smaller than the peak (from 1993-2013 as shown in Figure IV-12).

With full operation, social-structural and social-psychological change will also slow to an acceptable, comfortable pace because of this population leveling.

Thus, Table IV-18 as a whole describes the dynamics of social impacts contributing to what is labeled a "boom," and Figure IV-12 diagrams the dynamics of population growth underlying these impacts. Although numbers can be assigned in Table IV-12 but directions of impacts are shown for short and long-term.

The social impact and population growth dynamics which will be significant are common to energy development, with variations in length and seriousness of impacts depending upon interactions among factors related to prior history and characteristics of the community and its people as they compare with incoming workers and at what rates.

Because (with the exceptions noted below) these patterns are similar for each community and for each alternative, and the time sequences are assumed to be the same, we can now describe two cases in some detail and compare other communities and other alternatives with them. The seven communities are all undergoing boom development already, as discussed in Chapter III.

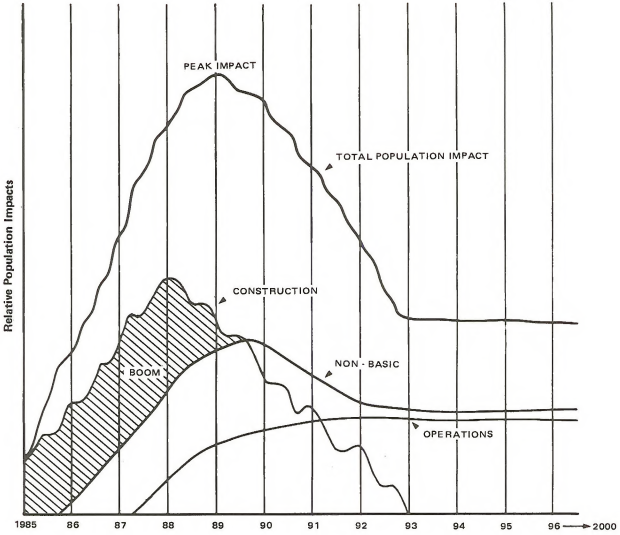


Figure IV-12 Population Impacts From Oil Shale Development by Years

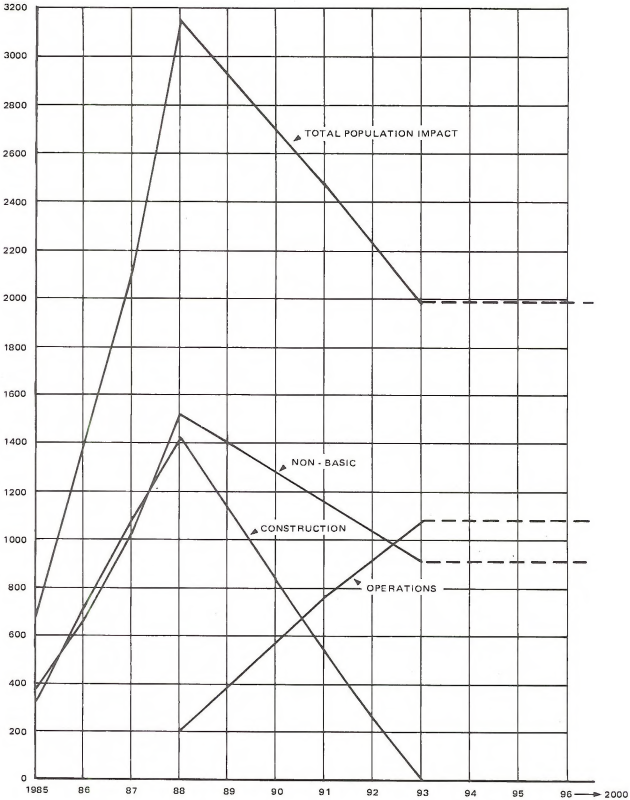


Figure IV-13 Population Impacts by Years, Low Production for Rifle, Colorado - One Tract

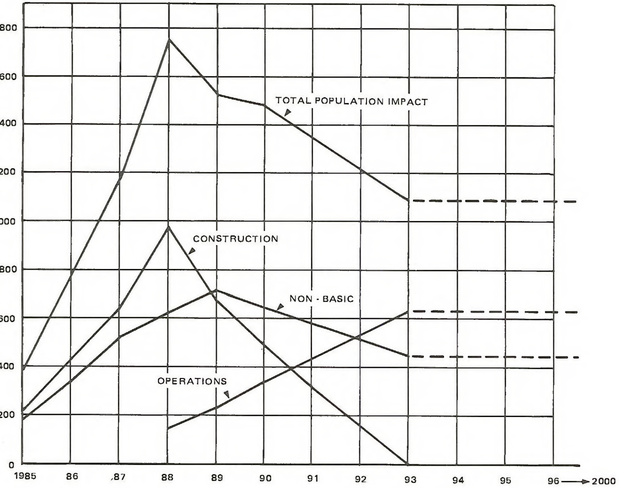


Figure IV-14 Population Impacts by Years, Low Production for Meeker, Colorado - One Tract

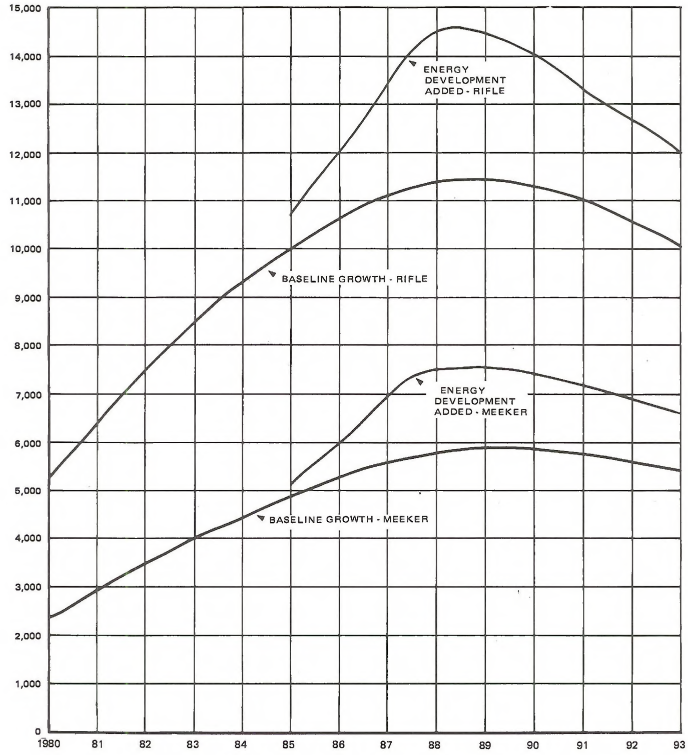


Figure IV-15 Population Impacts of Oil Shale Development in Baseline Growth 1980 to 1993 for Rifle, Colorado - Low Production Level and Meeker, Colorado - Low Production Level, One Tract

TABLE IV-19
PERCENT POPULATION IMPACT ABOVE BASELINE GROWTH AT PEAK YEAR EMPLOYMENT (1988)
AND AT FULL OPERATION (1993): ALL ALTERNATIVES BY COMMUNITY

	No Action High & Low	Percent Impacts Above Baseline Growth C-18 Low	C-11 Low	C-18 High	C-11 High	Both Tracts Low	Both Tracts High
Silt/Newcastle							
Peak Impact 1988	--	1.7*	1.7+**	2.2	2.2+	3.5	4.5
Full Operation 1993	--	1.2	1.2+	1.5	1.5+	2.4	2.9
Rifle							
Peak Impact 1988	--	27.9	27.9+	36.5	36.5+	55.8	73.0
Full Operation 1993	--	19.8	19.8+	19.8	19.8+	39.6	39.7
Parachute/Battlement Mesa							
Peak Impact 1988	--	.7	.7+	.7	.7+	1.3	1.3
Full Operation 1993	--	.4	.4+	.4	.4+	.9	.7
Glenwood Spgs./Carbondale							
Peak Impact 1988	--	2.1	2.1+	2.8	2.8	4.2	5.6
Full Operation 1993	--	1.3	1.3+	1.6	1.6+	2.6	3.2
Rangely							
Peak Impact 1988	--	9.2	9.2+	10.2	10.2+	18.4	20.5
Full Operation 1993	--	6.0	6.0+	6.0	6.0+	12.0	12.0
Meeker							
Peak Impact 1988	--	30.2	30.2+	37.2	37.2+	60.4	74.4
Full Operation 1993	--	19.8	19.8+	21.5	21.5+	39.6	42.9
Grand Junction							
Peak Impact 1988	--	.1	.1+	.1	.1+	.3	.2
Full Operation 1993	--	.5	.5+	.6	.6+	1.0	1.2

* All percentages were computed by dividing estimated baseline for the year into total population impact. The full operation percent is assumed to be continued as a permanent population increase for the duration of operations (to 2013). Baseline numbers include the Colony Project projections made before the shutdown of that operation.

** The Multi Minerals Corporation Project is expected to proceed on schedule unless the tract is leased, in which case the project would be absorbed into the C-18 development. Thus, if only C-11 is leased, the Multi Minerals Project would represent an additional impact in population. Where this is likely, percentages have a "+" mark shown.

TABLE IV-20
SEVERITY OF IMPACTS AT PEAK EMPLOYMENT (1988) AND
AT FULL PRODUCTION (1993) ALL COMMUNITIES, ALL ALTERNATIVES

Significance of Impact

Peak Employment (1988)	Full Production (1993)	Level of Severity of Impact
0-3%	0-2%	Insignificant
3-6%	2-5%	Low Severity
6-12%	5-10%	Moderately severe
12-30%	10-20%	Severe
30% +	20% +	Very Severe

Degree of Severity of Impacts by Community

	Insignificant	Low	Moderate	Severe	Very Severe
C-18 Only-Low	Silt/New Castle Parachute/B.M. Glenwood/Carb. Grand Junction	None	Rangely	Rifle Meeker	None
C-11 Only-Low	Silt/New Castle Parachute/B.M. Glenwood/Carb. Grand Junction	None	Rangely	Rifle Meeker	None
C-18 Only-High	Silt/New Castle Parachute/B.M. Glenwood/Carb. Grand Junction	None	Rangely	None	Rifle Meeker
C-11 Only-High	Silt/New Castle Parachute/B.M. Glenwood/Carb. Grand Junction	None	Rangely	None	Rifle Meeker
Both Tracts-Low	Parachute/B.M. Grand Junction	Silt/New Castle Glenwood/Carb.	None	Rangely	Rifle Meeker
Both Tract-High	Parachute/B.M. Grand Junction	Silt/New Castle Glenwood/Carb.	None	Rangely	Rifle Meeker.

The Alternatives and Impact Processes

For the No Action Alternative no social impacts would occur beyond those caused by the expected baseline growth as discussed below.

The two communities drawing the largest proportions of new residents from any of the aternatives would be Meeker and Rifle. Figures IV-13 and IV-14 show the estimated population impacts on these for the C-18 Alternative at a 25,000 bbl/day production rate.

These graphs demonstrate that the figures generated by the theoretical population model used for this EIS closely resemble the patterns indicated in Figure IV-12.

In Figure IV-15, the "total" lines from Figure IV-13 and IV-14 are shown as increments above the baseline growth. Baselines are drawn as curves plotted at three points: 1980 (US Census), 1988 and 1993 (BLM projections), representing growth expected from all other sources. For instance, without leasing, in 1988 Rifle would have about 11,300 people; with C-18 (low production rate), this would rise to about 14,500. If both tracts were leased at low level production (not shown; see Table B-3 in Appendix B), the figure would increase to about 17,600. The leasing impacts would obviously be upon an already rapid baseline growth rate. In the case of Rifle, the boom process would be far along in that the characteristics of the small ranching town would already have disappeared -- services and facilities expansion would have occurred, social structures would be largely formalized, power shifts would be taking place, etc. The new "boom" thus would be on top of an on-going rapid growth situation, and would tend to prolong a boom in progress rather than create a new boom.

Meeker's case would be similar except that having started on a smaller population base, the impacts of the "boom" would imply a more drastic earlier stage than would the Rifle case.

The theoretical population distribution model did not place secondary population in Silt or Parachute, nor construction and operations personnel in Glenwood Springs or Grand Junction. With these exceptions, Figures IV-13 and IV-14 typify the patterns of population impacts in the seven affected communities. In all cases Figure IV-15 is illustrative.

Thus, in Figure IV-15 and Table IV-18, we can see the shape of population impact curves, and the forms and processes of changes occurring among the various social components of communities.

Quality of Life

We now estimate the seriousness of these impacts across the alternatives and communities (Table IV-19). Detailed calculations underlying this summary (and the Figures already discussed) are in Appendix B Tables B-1 through B-5.

Short-term impacts are given in Table IV-19 as the percentage the peak number is of the baseline population for 1988. Longer term impacts are given as the percent the full operations and non-basic increase are of the baseline population for 1993. For example, the Silt/Newcastle baseline population for 1988 is 5,100 persons; the C-18 low production alternative would add an estimated 89 persons by 1988, a percent increase of 1.7. In 1993, the baseline is 4,900, with an estimated 59 persons added by full operation of C-18, or 1.2 percent.

The relationship between the 1988 short-term and 1993 long-term numbers is fixed by the population distribution model, so the severity of impacts is the some coincide for any community for both times, though the meaning of the impact would be different, as discussed below. Table IV-20 summarizes the estimated severity of impacts for each community under each alternative over the life of the operations.

In the short-term (1988 peak), Rifle and Meeker would experience severe quality of life deterioration under the mildest alternative (C-18 low production), and very severe deterioration for the single-tract high production and the Combined Alternatives. Rangely would suffer moderate impacts for all single tract alternatives, and would be severely affected by the Combined Alternatives. Quality of life for Silt and Glenwood would be only mildly affected for the Combined Alternative and would be insignificant for all single tract alternatives. Grand Junction and Parachute would experience no significant social impacts from any alternative.

At full production level, the negative quality of life impacts generally called "boom conditions" would have largely occurred and then declined with the expected slump, but there would be long-term (often permanent) residues that are socially significant. The population increase due to operations would stabilize for the life of the operation (2013). The expanded facilities, more and better social services delivery systems, more formal political processes with a more diverse power structure, more adequate shopping and entertainment choices, and other features of urbanization would generally remain even after 2013. The small town atmosphere and ethos with their associated psychological comforts for oldtimer citizens would be lost permanently.

The community as a whole would readjust to its new size, form and structure, and most newcomers and most oldtimers also would come gradually to feel psychological comfort in the new social context. But some permanent negative effects would have occurred. Some lives would have been touched by marital disturbances or divorce, mental stresses, alcoholism, crime; some of the elderly and the young would suffer from loss of social support systems; some ranchers and other oldtimers would have lost social status or financial security due to the power and economic shifts; and so on. Thus for some individuals, loss of life quality would be irretrievable and irreversible.

There are, however, winners: social gains for many, through better jobs and fuller lives, expansion of social choices, a widening of social horizons and opportunities for financial gain. These changes also tend to persist. Both the positives and the negatives are unavoidable.

Thus, while the quality of life for communities and for persons would fluctuate due to rapidity and degree of growth, social component, stage of process, and position in social structure, it is likely that over the long-term social benefits would outweight social losses for both.

ECONOMICS

Leasing of either or both of the tracts would cause significant economic consequences in the region. The consequences would center in Garfield and Rio Blanco Counties, and are expected to most heavily affect the communities of Rifle and Meeker.

They would include front end capital spending requirements for new housing and community facilities, loss of agricultural land to residential and commercial uses, competition for labor disadvantageous to local agriculture and business, and continued or worsened local inflation in housing costs.

Employment and Income

Table IV-21 shows expected employment and income impacts that would result from each alternative.

At the peak of project construction, anticipated to occur in 1988, Garfield County would experience an additional employment growth ranging from eight percent from the development of Tract C-18 in the low scenario to 22 percent if both tracts were developed and the high scenario conditions occurred. Rio Blanco County's smaller employment base would be increased at rates between nine percent and 37 percent under the same sets of conditions. Mesa County is expected to incur less of an impact, with growth rates ranging between zero and one percent, although a number of industries supplying the oil shale projects would expand. A total of anywhere from 2,400 to 8,000 new jobs would be created in the region. Construction and secondary industries would account for practically all of the new jobs during that period, since the operations (mining) phase of the projects would be just starting.

By 1993, with construction work virtually completed and the project(s) operating at a full production level, employment requirements would decline by about one-half. Impacts under the above-mentioned conditions would drop to a range of four percent to 11 percent in Garfield County and three percent to 19 percent in Rio Blanco County. Impacts to Mesa County would remain relatively low. Total jobs created would vary from 1,300 to 4,700, with slightly more in the secondary industries than in mining.

Impacts on wage and salary incomes would parallel those of employment, but would average a couple of percentage points higher because of the above-average wage rates paid in the construction and mining fields. Growth rates would vary from 11 percent in Garfield County and 12 percent in Rio Blanco County for the leasing of Tract C-18 under low scenario conditions to 27 percent and 44 percent in those two counties, respectively, if both tracts were leased under high scenario conditions.

Requirements for construction workers would far exceed the capacity of the local labor force. However, other major construction projects are expected to increase the construction work force considerably above present levels. It is estimated that about 50 percent of the construction jobs would be filled by in-migrants under the low scenario and from 60 to 70 percent under high scenario conditions. Continued growth that is forecast in Mesa County under high scenario assumptions would produce a tight enough labor market that most new jobs would be filled by newcomers. Not all of the in-migrants would become permanent residents since many of the construction workers would seek jobs elsewhere after completion of the projects.

The end of construction by 1993 would leave a temporary surplus of labor, and no net in-migration would be needed to fill the operations jobs. However, considerable change in types of workers would doubtless occur, with construction workers leaving and miners coming in.

TABLE IV-21
EMPLOYMENT AND INCOME IMPACTS
TOTAL EMPLOYMENT BY INDUSTRY GROUPS AND TOTAL LABOR INCOME (BASELINE PLUS IMPACT)
PROJECTED UNDER EACH ALTERNATIVE

	Low Scenarios				High Scenarios			
	No Action	Lease C-11 Only	Lease C-18 Only	Lease Both Tracts	No Action	Lease C-11 Only	Lease C-18 Only	Lease Both Tracts
Garfield County								
1988:Total Employment	20,800	22,900	22,500	24,600	23,600	26,300	25,900	28,700
Construction	3,400	4,400	4,400	5,400	6,500	7,800	7,800	9,100
Mining	3,100	3,200	3,000	3,100	4,100	4,200	4,000	4,200
All Other	14,300	15,300	15,100	16,100	13,000	14,300	14,100	15,400
Total Wage & Salary income (000)	$384,000	$434,000	$425,000	$476,000	$449,000	$514,000	$505,000	$571,000
1993:Total Employment	20,100	21,400	21,000	22,300	24,800	26,400	26,000	27,600
Construction	2,000	2,000	2,000	2,000	3,700	3,700	3,700	3,700
Mining	4,100	4,800	4,600	5,200	7,000	7,800	7,600	8,400
All Other	14,000	14,600	14,400	15,100	14,100	14,900	14,700	15,500
Total Wage & Salary income (000)	$362,000	$392,000	$382,000	$412,000	$491,000	$528,000	$519,000	$556,000
Mesa County								
1988:Total Employment	42,700	42,800	42,800	42,800	45,800	45,800	45,800	45,900
Construction	3,800	3,800	3,800	3,800	5,100	5,100	5,100	5,100
Mining	3,100	3,100	3,100	3,100	4,000	4,000	4,000	4,000
All Other	35,800	35,900	35,900	35,900	36,700	36,700	36,700	36,800
Total Wage & Salary income (000)	$660,000	$661,000	$661,000	$661,000	$742,000	$743,000	$743,000	$743,000
1993:Total Employment	44,000	44,200	44,200	44,500	48,900	49,100	49,100	49,400
Construction	3,400	3,400	3,400	3,400	4,600	4,600	4,600	4,600
Mining	3,600	3,600	3,600	3,600	5,800	5,800	5,800	5,800
All Other	37,000	37,200	37,200	37,500	38,500	38,700	38,700	39,000
Total Wage & Salary income (000)	$683,000	$686,000	$686,000	$689,000	$808,000	$812,000	$812,000	$815,000
Rio Blanco County								
1988:Total Employment	6,700	8,000	7,300	8,600	7,500	9,200	8,600	10,300
Construction	1,600	2,300	2,300	3,000	1,900	2,800	2,800	3,700
Mining	2,100	2,200	1,800	1,900	2,400	2,500	2,100	2,200
All Other	3,000	3,500	3,200	3,700	3,200	3,900	3,700	4,400
Total Wage & Salary income (000)	$144,000	$177,000	$161,000	$195,000	$162,000	$205,000	$190,000	$234,000
1993:Total Employment	6,400	7,200	6,600	7,400	7,400	8,400	7,800	8,800
Construction	900	900	900	900	900	900	900	900
Mining	2,500	2,900	2,500	3,000	3,100	3,700	3,300	3,900
All Other	3,000	3,400	3,200	3,500	3,400	3,800	3,600	4,000
Total Wage & Other income (000)	$139,000	$160,000	$144,000	$164,000	$164,000	$189,000	$173,000	$198,000

The construction and mining employment groups are shown separately because direct impacts would affect those groups. Indirect impacts would occur in the other industry groups, except in Mesa County where impacts to industries supplying the projects would also be included in the all other category.

TABLE IV-22
NEW HOUSING REQUIREMENTS
ADDITIONAL HOUSING UNITS REQUIRED (BASELINE PLUS IMPACT) UNDER EACH ALTERNATIVE

	Low Scenarios				High Scenarios			
	No Action	Lease C-11 Only	Lease C-18 Only	Lease Both Tracts	No Action	Lease C-11 Only	Lease C-18 Only	Lease Both Tracts
Garfield County								
Glenwood Springs - Carbondale								
1988	1,200	1,330	1,320	1,450	1,200	1,370	1,370	1,540
1993	920	1,000	990	1,080	920	1,020	1,020	1,120
New Castle-Silt								
1988	370	400	390	420	370	420	400	440
1993	300	320	300	320	350	370	350	380
Parachute-Battlement Mesa								
1988	2,700	2,730	2,720	2,740	3,580	3,610	3,600	3,630
1993	2,590	2,600	2,600	2,610	4,380	4,400	4,400	4,420
Rifle								
1988	2,040	3,160	2,930	4,060	2,040	3,550	3,310	4,830
1993	1,570	2,300	2,070	2,810	2,450	3,390	3,150	4,100
Mesa County								
Grand Junction								
1988	2,230	2,280	2,280	2,310	3,570	3,600	3,600	3,630
1993	2,960	3,140	3,140	3,330	5,790	6,010	6,010	6,230
Rio Blanco County								
Meeker								
1988	650	1,250	930	1,550	800	1,630	1,300	2,140
1993	540	950	630	1,040	800	1,330	1,000	1,520
Rangely								
1988	490	630	570	710	790	970	920	1,110
1993	450	550	490	580	760	870	820	940

Housing requirements shown are for all types, including temporary housing. The 1993 figures show new housing required by growth from 1980, not from 1988.

Population

Population impacts to communities depend on where workers choose to live. This analysis assumes that most workers will locate in Rifle and Meeker. Table B-1 in Appendix B shows the expected population impacts.

Impacts to those two communities would be significant under all alternatives in both scenarios and would be extreme if both tracts were leased. In the low scenario, Rifle would grow 19 percent by 1988 if Tract C-18 only were leased (the minimum impact) and 45 percent if both tracts were leased. In the high scenario, corresponding impacts would be 28 percent and 63 percent. Meeker would experience population increases ranging from 12 percent to 25 percent under the same alternatives in the low scenario and from 21 percent to 56 percent in the high scenario. The only other community reaching double digit impact percents would be Rangely, which would expand from 12 to 16 percent by 1988 if both tracts were leased. Again, impacts would lower by 1993 in all communities with the end of construction. Nevertheless, they would still be significant in those three communities, reaching as high as 35 percent in Rifle in the high scenario with both tracts leased (specific impact percents for all communities are shown in Tables IV-25b through IV-25d).

Housing

Additional housing requirements would be high in several communities during the construction period; however, some of these requirements would be temporary. Because those temporary demands may be handled by mobile home parks and man camps, a better measure of new housing needs is that of the operation work force. Therefore, Table IV-22 shows new housing requirements in both 1988 and 1993, even though those in 1993 are generally lower. It should be emphasized that the table shows new housing requirements: total required housing net of the 1980 housing supply as given by the census. The 1993 figures show new housing required by growth from 1980, not from 1988.

Proportionate impacts appear higher than those for population because of the deduction of current housing vacancies from the No Action Alternative figures. The analysis basically shows that the same communities -- Rifle, Meeker and Rangely -- would be most heavily impacted, especially if both tracts were leased.

Other Economic Impacts

Agriculture

No on tract impacts would occur to croplands. Between 125 and 465 animal unit months (AUMs) of grazing would be lost if the tracts were leased, depending on the alternative and method of mining (see Chapter IV, Grazing). The resulting annual losses to ranchers and local businesses and taxes would range from $9,000 to $32,000, as shown in Table IV-23.

Secondary impacts, resulting from population growth, would involve conversion of agricultural land to residential and commercial uses. Because it is impossible to anticipate how much of the converted land would be cropland and how much rangeland, the worst case situation is assumed that all would be cropland. Losses of cropland under the different alternatives would vary from 910 to 2,290 acres, in addition to the 6,770 to 10,160 acres that will be converted without the proposed action (see Chapter IV, Agricultural Lands). Using an average value per acre for crops grown in these counties gives the estimated impacts on crop sales shown in Table IV-23.

One other potential impact cannot be quantified: competition for labor. High-paying construction and mining jobs tend to draw workers out of other industries, including local trade and service as well as agriculture. The agriculture impact would be small in Rio Blanco County, where little hired labor is used, but would be more serious in Garfield and Mesa Counties. The effect on other local business would be significant in all three counties.

Wildlife

The local economic value of deer hunting lost (the principal game animal in that area) as a result of habitat destruction and road kills (assuming deer population reaches the habitat capacity - see Chapter IV, Wildlife) would vary from $9,000-$131,000. Little, if any, additional local economic loss would result from reduction of other wildlife because the present animal population exceeds hunting demand. Nonlocal losses would be negligible because of the numerous other hunting locations available in the region and the state.

Projected new housing requirements would aggravate the inflation in local land values and housing costs that has already occurred as a result of current developments. In the worst cases, where new housing requirements rise into the 20 plus percent range (see Tables IV-25b through IV-25d), housing costs would almost certainly get a further

upward push. In other cases, inflation would be kept from declining locally despite fluctuations in regional and national housing markets. The only way these effects could be prevented would be by major and early government efforts to set aside land and provide housing capital.

On the positive side, growth in employment and income would improve local business conditions and increase the variety of available shopping, especially in the smaller communities.

Development of oil shale would add to government revenues at all levels. The operations would pay royalties to the federal government, severance taxes to the state government, and property taxes to the county government. Employees and secondary businesses would pay property taxes, sales taxes, and other charges to the municipal and county governments. Portions of the royalties and severance taxes would be returned to the county and municipal governments where the operations are located.

Since the method for determining assessed valuation of oil shale has not been determined, it is impossible to project the impacts of the operations on property taxes. Also, severance taxes cannot be projected because the formula requires data on operating costs to determine taxable revenue. Impacts on both of these would undoubtedly be large.

The federal royalty rate is 12 cents per ton of shale, adjusted downward one cent for each gallon of average oil content less than 30 gallons per ton, and adjusted upward by the ratio of the current wholesale price for crude oil to that in March 1974. Additional royalties would be charged for nahcolite and dawsonite produced, based on price, but no market prices have yet been established for those minerals. Assuming production levels of 25,000-100,000 barrels per day (depending on the alternative and scenario), oil content of 30 gallons per ton, and using the 1981 average wholesale price for crude oil (ratio to the March 1974 price is 3.984), total annual royalties would amount to between $6,107,000 and $24,430,000. The State of Colorado receives 50 percent of federal royalties, which would come to $3,053,500 to $12,215,000 and 50 percent of those amounts would be returned to the county of origin, up to a maximum of $800,000. Thus, Rio Blanco County would receive $800,000 in federal royalty revenues under any of the alternatives.

Population and local business growth would add considerably to local residential and commercial property taxes and sales taxes, as shown in Table IV-24. These revenues would accrue to communities, where such growth would take place, while the taxes paid by an operation would go to the county. Rifle and Meeker would benefit the most, with Rangely, the Glenwood Springs-Carbondale area, and Grand Junction also receiving sizable amounts under certain circumstances.

Summary

Tables IV-25a through IV-25d summarize the economic impacts. Please note that percentage impacts in Table IV-25a are low because they are heavily weighted by Mesa County, the largest but least impacted county. Impacts to individual counties and communities in the other three tables provide a better measure of impact significance.

There is no objective standard for significance of economic impacts. Rather than use arbitrary percentage ranges to define significance levels, this analysis refers to impacts as "moderate," "large," etc. on a judgment basis. With the percentages given, readers should draw their own independent conclusions.

Parachute-Battlement Mesa, Rifle, Meeker, and possibly other communities may be heavily impacted by oil shale and other mineral developments assumed in the No Action Alternative, depending on the course of events. If that happens, even moderate impacts from these alternatives would have serious consequences when community resources are already stretched to the limit.

Leasing Tract C-11 alone would cause sizable economic impacts to Garfield and Rio Blanco Counties, with the largest impacts to Rifle and Meeker. Moderate impacts would be caused to Rangely. These communities would also benefit from increased tax revenues, roughly in proportion to their population impacts.

Leasing Tract C-18 alone would cause a similar pattern of impacts on a lesser scale because the Multi Mineral Corporation's sodium project would be absorbed in any oil shale operation on that tract. Impacts to Rifle and Meeker would still be fairly large.

Leasing both tracts would cause fairly large impacts to Garfield and Rio Blanco Counties and Rangely and major impacts to Rifle and Meeker. In this case, it is unlikely that the increased revenues received by communities would offset the capital and operating costs that would be necessitated by such rapid population growth, and the heavily impacted towns would need large infusions of assistance.

TABLE IV-23
IMPACTS ON AGRICULTURE
(THOUSAND DOLLARS)

	No Action	Lease C-11 Only	Lease C-18 Only	Lease Both Tracts
Impacts on grazing				
Low impacts				
Ranchers		$4	$4	$8
Local Business & Taxes		5	5	10
High Impacts				
Ranchers		7	7	14
Local Business & Taxes		9	9	18
Impacts on crop sales				
Low scenarios				
Garfield County	$208	$239	$239	$269
Mesa County	603	670	670	759
Rio Blanco County	33	46	46	62
High scenarios				
Garfield County	306	343	343	386
Mesa County	893	1,005	1,005	1,094
Rio Blanco County	53	72	72	89

Note: Low and high impacts result from different assumed mining techniques, not low and high scenarios as used elsewhere in this report.

* Less than $500.

TABLE IV-24
COMMUNITY REVENUE IMPACTS
ADDITION TO PROPERTY AND SALES TAX REVENUES PROJECTED UNDER EACH ALTERNATIVE

	Low Scenarios			High Scenarios		
	Lease C-11 Only	Lease C-18 Only	Lease Both Tracts	Lease C-11 Only	Lease C-18 Only	Lease Both Tracts
Garfield County						
Glenwood Springs - Carbondale						
1988	$150	$120	$260	$200	$170	$370
1993	100	70	170	130	100	230
New Castle - Silt						
1988	3	1	4	4	2	6
1993	1	*	2	3	1	4
Parachute-Battlement Mesa						
1988	1	1	2	2	1	3
1993	1	1	2	1	1	2
Rifle						
1988	720	560	1,290	970	810	1,790
1993	490	340	830	640	480	1,110
Mesa County						
Grand Junction						
1988	30	30	50	20	20	40
1993	110	110	220	130	130	260
Rio Blanco County						
Meeker						
1988	380	170	560	520	310	840
1993	280	70	340	350	140	490
Rangely						
1988	100	50	150	140	80	230
1993	70	20	90	100	40	130

* Less than $500

TABLE IV-25a
ECONOMIC IMPACTS BY ALTERNAIVE
SUMMARY -- TOTAL IMPACTED AREA

	Low Scenario			High Scenario		
	Employment (Percent)	Population (Percent)	Communities Revenue (000)	Employment (Percent)	Population (Percent)	Communities Revenue (000)
Lease C-11 Only						
1988	5	4	$1,384	6	5	$1,856
1993	3	3	1,052	3	4	1,354
Lease C-18 Only						
1988	3	3	932	4	4	1,393
1993	2	2	611	2	2	892
Lease Both Tracts						
1988	8	7	2,316	10	9	3,279
1993	5	5	1,654	6	6	2,226

TABLE IV-25b
ECONOMIC IMPACTS BY ALTERNATIVE
LEASE C-11 ONLY

	Low Scenario			High Scenario		
			Communities			Communities
	Employment (Percent)	Population (Percent)	Revenue (000)	Employment (Percent)	Population (Percent)	Revenue (000)
1988						
Garfield County	10	8		11	11	
Glenwood Springs Carbondale		2	$150		3	$200
Newcastle-Silt		2	3		2	4
Parachute-Battlement Mesa		0	1		1	2
Rifle		26	720		35	970
Mesa County	*	*		0	*	
Grand Junction		*	30		*	20
Rio Blanco County	19	19		23	24	
Meeker		28	380		35	520
Rangely		7	100		10	140
1993						
Garfield County	6	6		6	6	
Glenwood Springs Carbondale		1	100		1	130
Newcastle-Silt		2	1		2	3
Parachute-Battlement Mesa		0	1		0	1
Rifle		20	490		21	640
Mesa County	*	*		*	*	
Grand Junction		*	110		1	130
Rio Blanco County	12	15		14	16	
Meeker		20	280		24	350
Rangely		8	70		6	100

TABLE IV-25c
ECONOMIC IMPACTS BY ALTERNATIVE
LEASE C-18 ONLY

	Low Scenario Employment (Percent)	Low Scenario Population (Percent)	Low Scenario Communities Revenue (000)	High Scenario Employment (Percent)	High Scenario Population (Percent)	High Scenario Communities Revenue (000)
1988						
Garfield County	8	6		10	9	
Glenwood Springs Carbondale		2	$120		3	$170
Newcastle-Silt		2	1		2	2
Parachute-Battlement Mesa	0	1			1	1
Rifle		19	560		28	810
Mesa County	*	*		0	*	
Grand Junction		*	30		*	20
Rio Blanco County	9	8		15	14	
Meeker		12	170		21	310
Rangely		2	50		6	80
1993						
Garfield County	4	4		5	5	
Glenwood Springs Carbondale		1	70		1	100
Newcastle-Silt		0	*		2	1
Parachute-Battlement Mesa		0	1		0	1
Rifle		14	340		15	480
Mesa County	*	*		*	*	
Grand Junction		*	110		1	130
Rio Blanco County	3	4		5	6	
Meeker		4	70		10	140
Rangely		5	20		2	40

TABLE IV-25d
ECONOMIC IMPACTS BY ALTERNATIVE
LEASE BOTH TRACTS

	Low Scenario			High Scenario		
			Communities			Communities
	Employment (Percent)	Population (Percent)	Revenue (000)	Employment (Percent)	Population (Percent)	Revenue (000)
1988						
Garfield County	18	15		22	20	
Glenwood Springs Carbondale		4	$260		5	$370
Newcastle-Silt		2	4		4	6
Parachute-Battlement Mesa		1	2		2	3
Rifle		45	1,290		63	1,790
Mesa County	*	*		*	*	
Grand Junction		*	50		*	40
Rio Blanco County	28	28		37	38	
Meeker		40	560		56	840
Rangely		12	150		16	230
1993						
Garfield County	11	10		11	11	
Glenwood Springs Carbondale		3	170		3	230
Newcastle-Silt		0	2		2	4
Parachute-Battlement Mesa		1	2		1	2
Rifle		33	830		35	1,110
Mesa County	1	1		1	1	
Grand Junction		1	220		1	260
Rio Blanco County	16	19		19	23	
Meeker		25	340		32	490
Rangely		10	90		10	130

Note: Percent means percent of No Action Alternative
* Less Than one-half percent, or less than $500

TRANSPORTATION

Highways

Assumptions:

1. The majority of employees would use busing between the tract(s) and local communities. An average of 20 persons per bus is estimated.

2. Unless otherwise noted, by 1993 the sodium and alumina minerals shown in the Chapter II Product Transportation table for the direct mining method would be trucked to the railhead at Rifle. No products would be transported in 1988.

3. C-a and C-b Tracts would not truck any of their products.

4. The C-a to Rangely Road would not be used for product transportation due to lower construction standards.

5. 1980 Colorado State Department of Highways statistics were used as the basis for projections.

By 1993, State highway 13/789, between Rifle and Rio Blanco, Segment A (see Figure III-16) would experience traffic slowdowns, under the Combined Alternative low production rate. Some congestion and occasional decreases in traffic speed would result from either of the single tract alternatives high development scenarios, on Segment A. Under the combined alternative, high production rate traffic on Segment A would often slow to 40 mph. Traffic on the southern portion of Piceance Creek Road Segment B, would often slow to 30 mph.

See Table IV-26 for details on traffic congestion. Large numbers of product haul trucks would be the primary source of the traffic congestion. The number of haul trucks is shown in Table IV-27. See Table IV-28 for highway damage costs from product hauls.

Similar to the effects on highway damage, the number of accidents would be highest under the Combined Alternative high scenario and lowest under the single tract low scenario alternatives. Tables IV-29 and IV-30 show the number of total accidents and fatal accidents for the affected segments.

The impacts on the highways would be reduced to slightly above those of the No Action Alternative if products are not trucked on the highway. Pipelines, a rail spur, slurry pipeline, four lane highway, conveyor or private haul road from the sites to Rifle would eliminate the impacts on segments A and B. Of these a four lane highway would be expensive to build and maintain, water supply for a slurry pipeline would not be adequate, it would be very difficult to obtain easements for a private haul road and a conveyor system would be extremely long. Probably the most feasible way to transport the products would be by pipeline for shale oil and rail for solid minerals.

Railroads

The effects of the estimated increase in rail traffic through Rifle, to load shale minerals, would not be significant.

NOISE

Significant noise increases would occur resulting from machinery operations on the tracts and from increased traffic on Colorado highway 13/789 and Rio Blanco County Road 5 (Piceance Creek Road). The Environmental Protection Agency (EPA) identifies 55 decibels (db) as the significant threshold for sustained noise to a listener. This level of noise, and higher, could cause minor physiological reactions, such as irritability and annoyance, depending upon the sensitivity of the listener.

Noise levels from operating equipment on-site would be raised from 40-45 db to 80-90 db, at the tract boundary. This amount of increase would carry over a nine mile radius from the tract(s). So while the ceiling level (90 db at 50 feet) would not be experienced by listeners at the periphery of the nine mile radius, the amount of increase would be clearly noticeable.

The closest residences are approximately five miles from the tract(s). Because of intervening terrain they are protected from any significant effects of on site noise increases, although highway noise would be noticeable and may adversely affect the esthetics of the basically quiet, rural setting, again, depending on the sensitivity of the listeners.

Noise increases from the tract(s) would affect the ranches along Piceance Creek to varying degrees, depending upon alternative and operation. Naturally, more noise would be generated during peak operation years (1993) than construction (1988). Because Tract C-11 is somewhat closer to more ranches on Piceance Creek, it would consequently result in more affects produced. However, the combined effects resulting from both tracts operating at the same time would not be significantly more than

TABLE IV-26
UTILIZED PERCENT OF HIGHWAY CAPACITY
WITH PEAK HOUR TRAFFIC

Highway Segment	No Action	C-11	C-18	Combined
1988 Low				
A Rifle to Rio Blanco	53	61	58	66
B1 Rio Blanco to Ryan Gulch	22	26	24	29
B2 Ryan Gulch to White River City	9	11	9	11
C Meeker to Rio Blanco	36	41	39	43
D Meeker to White River City	22	24	22	25
E Rangely to White River City	18	20	19	20
1988 High				
A	56	67	64	75*
B1	24	29	29	35
B2	10	13	12	14
C	39	49	44	50
D	24	27	26	27
E	21	22	21	23
1993 Low				
A	49	72	66	90*
B1	15	39	35	59
B2	8	13	12	18
C	36	39	38	41
D	20	22	21	23
E	18	24	24	30
1993 High				
A	57	100**	94**	137**
B1	24	70	67	111
B2	9	23	22	36
C	38	42	41	45
D	22	24	22	24
E	21	33	32	44

* Numbers near 85 percent and up to 90 percent indicate momentary traffic slowdowns.
** Numbers just below 100 percent indicate some traffic slowdowns by 10 mph while numbers of 100 percent and above indicate very frequent slowdowns of 10 mph.

TABLE IV-27
PREDICTED NUMBER OF ADDITIONAL HAUL TRUCKS PER DAY

Production Level For 1993	No Action	C-11	C-18	Combined
		FOR DIRECT AND MINE ASSISTED IN-SITU MINING		
Low				
A	180	1,119	939	2,058
B1	180	1,119	939	2,058
B2	--	322	322	644
C	--	--	--	--
D	--	--	--	--
E	--	322	322	644
High				
A	180	2,238	2,058	4,296
B1	180	2,238	2,058	4,296
B2		644	644	1,288
C				
D				
E		644	644	1,288
		FOR TRUE IN-SITU MINING **		
Low				
A	180	220	40	260
B1	180	220	40	260
B2	--	322	322	644
C	--	--	--	--
D	--	--	--	--
E	--	322	322	644
High				
A	180	440	260	700
B1	180	440	260	700
B2	--	644	644	1,288
C	--	--	--	--
D	--	--	--	--
E	--	644	644	1,288

* There would be no production from either tract in 1988
** True in-situ mining will produce only shale oil and caustic soda

TABLE IV-28
ANNUAL HIGHWAY DAMAGE FROM PRODUCT HAULS

Alternatives	Impacted Segments Dollars in Thousands A*	B*	B2**	E**
No Action 1993 (Both Scenarios)	222	218	0	0
DAMAGE FROM DIRECT AND MINE ASSISTED IN-SITU METHODS				
C-11, 1993, Low	1,380	1,358	412	752
C-11, 1993, High	2,760	2,716	824	1,504
C-18, 1993, Low	1,158	1,140	412	752
C-18, 1993, High	2,316	2,280	824	1,504
C-11 & C-18, 1993, Low	2,538	2,498	824	1,504
C-11 & C-18, 1993, High	5,076	4,996	1,648	3,008
DAMAGE FROM TRUE IN-SITU METHOD				
C-11, 1993, Low	270	270	412	752
C-11, 1993, High	540	540	824	1,504
C-18, 1993, Low	50	50	412	752
C-18, 1993, High	490	490	824	1,504
Comb, 1993, Low	320	320	824	1,504
Comb, 1993, High	1,030	1,030	1,648	3,008

* Damage resulting from: trucking minerals other than shale oil.

** Damage resulting from trucking shale oil.

Note: The dollar values represent increased maintenance costs and the cost of shortened highway life.

TABLE IV-29
PREDICTED TOTAL VEHICLE ACCIDENTS PER YEAR

Production Level by Year Road Segment	No Action	C-11	C-18	Combined
Low 1988				
A Rifle to Rio Blanco	101	117	110	126
B1 Rio Blanco to Ryan Gulch	31	38	36	42
B2 Ryan Gulch to White River City	13	17	14	18
C Meeker to Rio Blanco	81	91	86	95
D Meeker to White River City	29	32	30	34
E Rangely to White River City	53	56	53	56
Total	308	351	329	371
High 1988				
A	108	129	122	143
B1	36	45	43	51
B2	15	20	18	22
C	87	100	99	111
D	32	37	34	38
E	60	66	62	67
Total	338	397	378	432
Low 1993				
A	93	138	126	171
B1	23	58	51	87
B2	12	23	21	32
C	81	88	84	91
D	28	30	28	31
E	51	70	68	86
Total	288	407	378	498
High 1993				
A	108	191	179	262
B1	36	103	97	164
B2	15	36	34	55
C	86	94	92	100
D	29	32	30	33
E	59	94	92	126
Total	333	550	524	740

TABLE IV-30
PREDICTED FATAL VEHICLE ACCIDENTS PER 10 YEAR PERIODS *
(1 OR MORE FATALITIES PER ACCIDENT)

Production Level by Period Road Segment	No Action	C-11	C-18	Combined
1988 Low				
A Rifle to Rio Blanco	6	7	7	8
B1 Rio Blanco to Ryan Gulch	3	3	3	4
B2 Ryan Gulch to White River City	1	1	1	1
C Meeker to Rio Blanco	5	6	5	6
D Meeker to White River City	3	4	3	4
E Rangely to White River City	6	6	6	6
Total	24	27	25	29
1988 High				
A	7	8	8	9
B1	3	4	4	4
B2	1	2	1	2
C	5	6	6	7
D	4	4	4	4
E	7	7	7	8
Total	27	31	30	34
1993 Low				
A	6	8	8	11
B1	2	5	4	7
B2	1	2	2	3
C	5	5	5	6
D	3	3	3	3
E	6	8	8	10
Total	23	31	30	40
1993 High				
A	7	12	11	16
B1	3	9	8	14
B2	1	4	3	5
C	5	6	6	6
D	3	4	3	4
E	7	11	10	14
Total	26	46	41	59

* The projected number of accidents over a 10 year period is based on the number of fatal accidents for the alternatives in 1988 and 1993 extended over a 10 year period.

TABLE IV-31
SUMMARY OF DAILY ENERGY REQUIREMENTS

Energy Type	Low Production Rate (25,000 BBLs/day)			High Production Rate (50,000 BBLs/day		
	Direct Mining & Surface Retort	Mine Assisted In-Situ	True In-Situ	Direct Mining & Surface Retort	Mine Assisted In-Situ	True In-Situ
Direct Electrical	642,145 kwh	419,250	2,216,350 kwh	1,332,800 kwh	879,360 kwh	4,431,070
Direct Petroleum Direct	17,760 gal	46,000 gal	33,271 gal	95,107 gal	32,407 gal	66,542
Natural Gas Total	900,000 scf	900,000 scf	900,000 scf	1,800,000 scf	1,800,000 scf	1,800,00 scf
Energy Produced* Total	1.45×10^{11}	1.45×10^{11}	1.45×10^{11}	2.9×10^{11}	2.9×10^{11}	2.9×10^{11}
Energy Consumed* Energy	56.79×10^{9}	33.79×10^{9}	39.72×10^{9}	75.2×10^{9}	63.11×10^{9}	75.11×10^{9}
Ratio of Energy Out: Energy In	2.55:1	3.65:1	3.65:1	3.86:1	4.60:1	3.86:1

* In BTU's
kwh = kilowatt hour
gal = gallons
scf = standard cubic foot

one tract on these ranches. Recreational users, especially hunters, would be displeased by the increased noise near the tract(s).

Noise increases along the roads between Rifle and the tract(s), caused by increased traffic would vary considerably, depending upon alternative. Only moderate noise increases would result during the construction period and for true in-situ methods of mining. True in-situ would not require as many trucks for hauling minerals than the other methods would.

All alternatives that involve the other mining methods, during the peak operation years would produce some degree of significant noise increases along the affected road segments. Increases in noise levels would be as follows:

One tract, low level production - 3 db (Noticeable increase)

Both tracts, low level production - 5 db

One tract, high level production - 5 db

Both tracts, high level - 9 db (almost doubling the preceived noise level)

Existing noise levels along these road segments (measured at 50 feet) are currently about 69 db. The above increase would add significant noise increases and would affect those residences along these roads to varying degrees, depending upon distance from the road and sensitivity to noise.

NET ENERGY ANALYSIS

A net energy analysis was completed for each development scenario and production rate. Because a detailed mining and production plan is beyond the scope of this document, general mining and production plans were assumed for use in the energy analysis. Therefore, the energy analysis for C-11 is the same as C-18.

The methodology used in the net energy analysis is set forth in, *Energy Analysis Handbook for Oil Shale Development*. The handbook was developed under a contract with Colorado School of Mines Research Institute for the BLM (Melcher 1982). The methodology attempts to quantify the energy used to produce energy. The methodology employed "trajectories" broken into modules for each production scenario and rate. Each direct and indirect energy input was traced back to resources in the ground, forming the parameters of the study. The analysis does not include an energy assessment of unrecovered resources. Energy input included operational, transportation, materials and infrastructure energies.

Table IV-31 indicates the daily, direct energy requirements needed for multiple mineral production by energy type and production scenario. The table would seem to indicate that for maximum efficiency, mine assisted in-situ would be the best retorting technology. However, mine assisted in-situ has approximately five percent less recovery rate when compared to room and pillar mining and aboveground retorting. Also, shale oil produced by mine assisted in-situ retorting is better suited for middle distillate (diesel) cuts during refinement while aboveground "Type 4" retorting (a preheated solid comes into contact with the oil shale for retorting) produces shale oil better suited for high distillate (gasoline, kerosene) cuts during refinement.

The energy output to input ratio shown on the table ranges from 2.5-4.6 to 1. These ratios are lower than other energy products such as coal because oil shale retorting is very energy intensive and the energy required to produce soda ash, nahcolite and alumina is also included. It should be noted that the major energy required to produce shale oil is electricity, which has less utility than oil.

The net energy analysis does not vary by tract and differs only by development scenario and production rates. At 25,000 bbls/day or 50,000 bbls/day, either tract would produce approximately 8 million or 16 million barrels of shale oil respectively each year. Based on 1981 import figures, this production represents 0.5 percent or 1.0 percent of our annual oil imports respectively. The combined alternative would produce either 16 million or 32 million barrels of shale oil. These represent 1.0 percent or 2.0 percent of our annual oil imports.

Electrical generation requirements for either tract will require from 21.9 to 230.8 megawatts of generating capacity, depending on the production scenario and rate. Projections by the Public Utilities Commission indicate that by 1991 Colorado will be a net importer of electricity. The electrical demands of the tracts could be met by increasing imported electricity or by building another generating station within the state. It is unclear whether excess electrical generating capacity is available within the Western Area Power Administration's region. The Moon Lake power plant in Bonanza, Utah may build a second 350 megawatt unit. Also, Colorado Ute Electric is exploring the potential for another generating station in Colorado.

Onsite electrical generation could reduce the electrical requirements in the production process. For example, at Tract C-b the estimated potential for off tract export of surplus electrical power is from 300 to 400 megawatts from low BTU gas boilers, gas turbines, and waste heat boilers. This would be accomplished by recycling the low BTU off gases produced in the retort into a steamboiler

or a gas fired generator. However, the technology for low BTU gas fired generators is in its infancy and it is unclear whether they will be technologically and economically viable. Energy requirements for mine assisted in-situ could be cut by six percent and for aboveground retorting by eight percent using this co-generation technology. It is unclear whether true in-situ could adopt co-generation technology in its operations.

EXISTING RIGHTS

Existing rights-of-way could be impacted depending on the mining technique used. The direct mining, surface retort and the mine assisted in-situ mining methods could impact the rights-of-way by either subsidence or by being covered with spent shale. The true in-situ method could impact the rights-of-way by surface disturbance associated with intensive roads, pipelines and well pad construction needed for that mining method.

Dewatering of the upper level aquifers would impact the public water reserves located on the tracts and could affect public water reserves in the immediate vicinity of the tracts. Those public water reserves in the immediate vicinity of the tracts should be monitored in accordance with "Environmental Stipulations," Section 1(c)(2) of the lease (Appendix A). Private and state (Division of Wildlife) along Piceance and Yellow Creeks could also be impacted.

Leasing of the tracts would complicate to some extent concurrent development of oil and gas and oil shale. An agreement with Mineral Management Service, the oil and gas lease holder and the oil shale leaseholder, to allow for the orderly development of both leases would be necessary. This would involve special stipulations being put into the Application for Permit to Drill to protect the mining and recovery of oil shale deposits. A similar stipulation would also be put into new oil and gas leases located within the tract boundaries.

Prior to any oil shale leasing of Tract C-18, an agreement would have to be developed between the government and the current sodium lease holder that would assign the sodium lease to the successful bidder. This assignment will be announced in the *Federal Register* concurrently with the announcement of the lease sale, at least 30 days prior to the sale.

SUMMARY OF SIGNIFICANT IMPACTS

The significant impacts described in this chapter are summarized below. In addition, recommended mitigation measures to address some of these impacts are proposed in the "Uncommitted Mitigation" section. This section is a general discussion of the impacts anticipated for the development alternatives. For a more detailed discussion of impacts and their magnitude, refer to the appropriate resource element in this chapter. A comparative summary of impacts of each alternative is included following each alternative described in Chapter II.

Adverse Environmental Effects Which Cannot Be Avoided

Air Quality -- Some pollutants of TSP, NO_x and SO_2 will enter the atmosphere regardless of alternative selected or development scenario. However, compliance with state and federal laws should keep these impacts to a minimum.

Geology -- Depending upon the development scenario, some 75 percent or more of the oil shale resource and associated minerals would be unrecoverable. Currently unknown technologies could conceivably recover more of the in place reserves in the future.

Floodplains, Alluvial Valleys and Agricultural Lands -- Between 910 and 2,290 acres of agricultural lands will be converted to urban uses adjacent to existing communities in Mesa, Garfield and Rio Blanco Counties. Depending on the alternative selected and the rate of production, anywhere from 0.3 to 0.9 percent of existing agricultural lands may be urbanized with a corresponding decline in agricultural production. Adequate land to replace these impacted areas is unavailable.

Soils -- Soil productivity on 1,200 to 6,800 acres would be reduced during the life of the mine. An undetermined amount of soil and plant nutrients would be displaced from the mined tracts due to erosion.

Hydrology -- Water in the vicinity of the lease tract may require treatment prior to municipal or stock water use. This is due to incomplete control of leachate from spent shale wastes and subsurface retorts. In addition springs may be permanently lost due to mine dewatering.

Vegetation -- Vegetation on 1,200 to 6,800 acres would be removed from portions of the site during the life of the mine, but would be subse-

quently reclaimed. Undiscovered threatened or endangered plants may be destroyed, resulting in the potential loss of valuable biological data. A temporary loss of 125 to 465 AUMs would occur during the life of the mine, depending on the alternative and development scenario. Up to 4,800 acres of pinyon-juniper woodlands destroyed during mine development would likely be permanently lost since reclamation would be unlikely to reestablish pinyon and juniper trees to pre-disturbance levels. This loss would not be serious in terms of forest management, but would be important locally in terms of thermal cover loss for mule deer.

Wildlife -- There would be a temporary loss of 1,200 to 6,800 acres of wildlife habitat and animal production on lands that would be ultimately reclaimed. A permanent loss of 310 to 2,290 acres of habitat would result from urban development and road construction. Animals would also be lost due to increased vehicle/wildlife accidents and poaching. The estimated annual increase in vehicle related mule deer kills range from 111 to 2,082 depending on alternative and production level. A reduction in habitat effectiveness for big game will result from human disturbance due to human population increases. Habitat loss and reduction in habitat effectiveness would result in a reduction of mule deer carrying capacity from BLM-DOW population objectives by 151 to 549.

Cultural Resources -- Destruction or loss of cultural resources could occur if inadvertent disturbance to previously undetected subsurface archaeological sites takes place during construction associated with project development. Possible vandalism due to increased human activity would also be an unavoidable adverse impact.

Paleontological Resources -- Many insects, plant and vertebrate fossils could be destroyed during the construction phase, because they might not be seen due to their small size. Since similar plant and insect fossils probably occur in areas outside the sites, the loss would be small.

During shaft sinking, drifting or crosscutting, the loss of vertebrate fossils (especially well preserved fish fossils) would represent a greater loss to science because their salvage is practically impossible under these conditions.

Recreation -- Direct impacts resulting from any of the alternatives include the possible displacement of hunting and camping activities and access on the tracts. Indirect impacts include the possibility for increased hunting pressure in the area due to increased local population growth. This could result in decreases in hunter success and even hunting opportunities if a permit system is implemented by the Colorado Division of Wildlife.

Socioeconomic -- Significant impacts vary according to the rate of production and the number of employees required. These include demands on local public and private resources for new housing and other capital improvements, competition for labor disadvantageous to local agriculture and business, and local inflation. Also lost would be the lifestyles and values associated with the small ranching towns that will grow into larger communities with a more diverse population, economy and power structure.

Transportation -- Increases in traffic on local roads will result in more accidents, fatalities and road repair costs which will vary with the number of employees and the amount of production of each alternative.

Noise -- The increased truck traffic between the proposed tracts and Rifle would result in increased noise levels. This could be a significant impact only to residences located within 500 feet of the road under the Combined Alternative with a high production rate.

Existing Rights -- Public water reserves may be permanently lost due to mine dewatering.

Surface Reclamation and Solid Waste Disposal -- Exposure of surface disposal piles is unavoidable. The location, design, compaction and natural cementation of the wastes would determine the degree of impact.

The Relationship Between Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity

Air Quality -- Air pollution during the life of the mine may result in cumulative, long-term impacts to human health and vegetation. While short-term effects are thought to be insignificant, not enough is known about the long-term effects of air pollution to accurately predict their impact.

Geology -- Recovery of oil shale and associated sodium minerals using present technology in the short-term, would result in a permanent loss of 75 percent or more of the resources. This is due to the potential of developing new technologies in the future that may be more efficient at resource recovery.

Floodplains, Alluvial Valleys and Agricultural Lands -- Conversion of 910 to 2,290 acres of agricultural land to urban use as communities expand will result in the long-term loss of the lands' agricultural productivity.

Soils -- Soil productivity lost on 1,200 to 6,800 acres during the mine life should be restored to pre-disturbance levels with proper reclamation practices. The exception could be on up to 2,000 acres of spent shale disposal piles where limited soil cover may be a less productive medium.

Hydrology -- Short-term use of the surface and groundwater resources could cause some private, state and public springs, and wells to dry up in the vicinity. Flow of the White River at the confluence with the Green River will be reduced by approximately four percent for full development of 100,000 bbls/day production, two percent for 50,000 bbls/day production, and one percent for 25,000 bbls/day production per year for the short-term. Salt loads to the White River would be reduced over the short-term. However recovery of the groundwater and surface water systems should recover once mine dewatering closes.

Vegetation -- Vegetation on 1,200 to 6,800 acres would be lost through surface disturbance in all alternatives, varying by development scenario. In the long-term, lands impacted under the direct mining with surface retort or mine assisted in-situ methods should return to their potential productivity and natural condition with the possible exception of vegetation on 2,000 acres of spent shale piles. Lands impacted under the true in-situ method should return to a condition where forage production would probably be increased over the existing productivity levels. The potential loss of undiscovered rare or sensitive plants may result in their becoming threatened or endangered as more surface disturbance in the area occurs. Short-term loss of AUMs will be compensated by long-term increases in forage productivity and potentially more AUMs following successful revegetation of the disturbed areas. Pinyon-juniper woodlands disturbed during the life of the project could be reclaimed to existing levels of productivity within 50 to 75 years. Natural regeneration would take up to 100 to 150 years.

Wildlife -- Urban development and construction of new road systems would be a permanent loss of wildlife habitat on 310 to 2,290 acres. Reclamation may not adequately replace wildlife thermal cover or preferred browse of similar type, equal in quantity and quality to that destroyed or affected. Seventy-five to 150 years may be required before adequate reestablishment of pinyon-juniper or other overstory vegetation occurs to winter range. A permanent human population increase would result in continuous secondary off-tract impacts to the wildlife resource. Although unquantifiable, these consequences indicate a decline in wildlife populations, habitat condition, and quantity of habitat available in the long-term.

Cultural Resources -- The majority of impacts to cultural resources could occur as a result of surface disturbance from oil shale development. If destruction of cultural sites results, this would create a permanent loss of data.

Paleontological Resources -- Loss of paleontological resources through surface and subsurface disturbance would significantly affect the scientific value of the resource in the long-term if steps are not taken to salvage exposed fossils. If left unprotected, they would eventually be lost through weathering or vandalism. This is especially true of the vertebrate, rare plant and late Eocene insect fossils.

Recreation -- As game animal populations are reduced, so are the hunting opportunities that provide the greatest recreation in the area. The degree of impact resulting from any of the alternatives would affect a relatively small part of the total opportunities in the region.

Socioeconomics -- Almost all of the negative socioeconomic impacts would be short-term in nature: overloaded services and facilities, housing shortages, overworked police, overcrowded classrooms, increases in crime, alcoholism, mental illness, etc. In the long-term, many of these problems would give way to beneficial effects such as housing and infrastructure improvements, growth and diversification of local retail trade and services, and an easing of the social, psychological and structural strains associated with rapid growth.

Transportation -- Increased road use, especially from mineral product haul trucks, would significantly increase highway damage and costs to taxpayers in the long-term.

Existing Rights -- During the life of the mine, public water reserves may be lost due to mine dewatering. Oil and gas lease holders may be denied access to their leases, effectively postponing oil and gas development on tract until the end of mine life. Some pipelines and road rights-of-way may be permanently relocated due to mining and waste disposal activities.

Surface Reclamation and Solid Waste Disposal -- If suitable plant growth material is not used to cover spent shale to a depth suitable for plant growth, then reclamation of spent shale disposal piles could take significantly more time and effort to achieve a stable and acceptable vegetative cover. If a suitable depth of plant growth material is not obtained, then long-term establishment of mature shrub and pinyon-juniper species may be impossible due to their rooting depth requirements.

Short-term reclamation, under the true in-situ scenario, may be intensive due to its widespread

disturbance. However, long-term reclamation will be less difficult than for the other mining and retorting methods due to the absence of surface waste disposal piles. Surface waste disposal piles may be reclaimed in the short-term, however with average erosion rates, areas of established vegetation will decrease as the pile becomes exposed over the long-term.

Upon decommissioning of mine facilities, monitoring and maintenance of waste disposal piles may become the responsibility of the Federal Government should the company refuse to continue monitoring and maintenance activities due to the expense.

Introduced species in the seed mixtures will dominate reclaimed areas in the short-term as long as fertilizer and irrigation is utilized to establish vegetation cover under standard reclamation practices. However, as the fertilization and irrigation is discontinued, native species will start to dominate the reclaimed areas over the long-term.

Irreversible or Irretrievable Commitments of Resources

Air Quality -- Some degradation of air quality will be irreversible due to established urbanization in the area after closure of the oil shale facilities.

Geology -- Under the direct mining and surface retorting development scenario, 75 percent of the oil shale, and undetermined quantities of the nahcolite and dawsonite would be left unrecovered. Mine assisted in-situ and true in-situ processing would result in even more resources being irretrievably lost.

Floodplains, Alluvial Valleys and Agricultural Lands -- Urbanization of agricultural lands is permanent and results in an irretrievable loss of agricultural production from those lands.

Soils -- Soil and nutrients lost to erosion while sites are disturbed would be irretrievable. The amount of soil lost is related to the amount of area disturbed under each alternative and development scenario, and the success of erosion control on-site.

Hydrology -- Loss of some springs, and wells due to mine dewatering may be irreversible. Water quality degradation due to leachates may be irreversible. Mixing of the upper and lower aquifers through subsurface and mine dewatering retorting in the Mahogany Zone could be irreversible.

Vegetation -- The potential loss of biological data from undiscovered threatened, endangered or sensitive plants would be irretrievable. While the vegetation productivity would be restored through reclamation at the end of mine life, the loss of 125 to 465 AUMs annually during mine life would be irretrievable.

Wildlife -- Wildlife habitat lost on 310 to 2,290 acres due to urban expansion and road construction would be irretrievably lost.

Cultural Resources -- Destruction of cultural resources would result in an irretrievable loss of additional information to the existing scientific data base.

Paleontological Resources -- The paleontological resources are non-renewable; once lost or destroyed they are irretrievable. It is important that at least a representative sample of the fossil record be preserved.

Recreation -- Loss of recreation opportunities are tied to the loss of game wildlife habitat. The irretrievable loss of habitat to urban expansion and roads would result in a permanent loss of hunting opportunities. Total irreversible losses would be relatively minor, however.

Socioeconomics -- As agricultural land is irretrievably converted for urban expansion, $800,000 to $1,500,000 of annual crop production could be permanently lost. Economic resources would be irretrievably committed to the construction of houses, capital improvements, and commercial, industrial and public structures. Power structure shifts are generally irreversible, as are the changing lifestyles and values of the communities originally built on a western rural cultural base.

Transportation -- Increased use of the highways would result in increased traffic accidents, fatalities and property loss proportionate to the rate of production under any alternative.

Possible Conflicts With The Objectives of Federal, Regional, State and Local Land Use Plans, Policies and Controls for the Area

None of the proposed alternatives would directly conflict with the land use plans of any other agency or governmental entity with jurisdiction in the area concerned. Permitting and other controls have been established at the Federal, State and local levels that must be complied with.

Minor adjustments to the Bureau of Land Management's Allotment Management Plan for the Square S Allotment will be required. The existing Management Framework Plan for the White River

Resource Area provides for such adjustments in potential oil shale lease areas.

Mitigation Measures That Could Further Ameliorate The Anticipated Impacts But Are Not Required By BLM (Uncommitted Mitigation)

Air Quality -- Residual air quality impacts could be mitigated through additional control of emissions from existing sources. Increased study of pollution impacts to Air Quality Related Values, and additional background monitoring to better assess regional impacts would assist in better understanding of air quality problems associated with oil shale development in the Piceance Basin.

Geology -- Since the proposed tracts are located over the richest resources in the Piceance Basin, mining could be postponed until proven mining technology could recover more of the in place reserves than existing technology. While such technology development is unlikely in the near future, improved processing techniques may eventually evolve.

Floodplains, Alluvial Valleys and Agricultural Lands -- In order to direct urban expansion away from agricultural lands, public lands adjacent to communities could be designated for disposal to be used for this purpose. Local planning and zoning is the best tool to control agricultural land conversion, and should be utilized by local governments where this is a problem.

Surface disturbing activities should avoid identified alluvial valleys and floodplains.

Soils -- A minimum of 24 inches of suitable plant growth material should be placed on all spent shale disposal piles to ensure that soil productivity could be returned to pre-disturbance levels.

Hydrology -- Leaching of spent shale wastes prior to backfilling or abandonment of subsurface retorts will reduce the potential effects of toxic leachates for the long-term. Grouting or filling of the subsurface retorts and backfilling areas with an insoluable material would decrease the potential for leachates in the hydrologic systems.

Springs and public water reserves on and off-tract should be monitored to determine the effect of mine dewatering.

Retorts could be operated in excess of 800 degrees Centigrade to increase the insoluable content of spent shale.

A zero discharge policy similar to C-a and C-b should be adopted on any new lease tract.

Vegetation -- Additional field surveys for threatened, endangered or sensitive plant species should be conducted prior to any surface disturbing activities. Avoidance of any identified threatened or endangered plant species locations and pinyon-juniper woodlands by relocating surface facilities is recommended.

Wildlife -- To reduce poaching, the carrying of firearms by employees while on the job or in company-owned vehicles, with the exception of security guards, would be prohibited.

To reduce highway mortality to wildlife the lessee would provide busing for workers from the affected communities to the tract site.

A proven method of mitigating wildlife impacts on a regional basis has been to establish an "industrial association" among the affected government agencies (BLM, MMS, DOW and USFWS), the lessee(s), C-a, C-b and other energy development companies in Piceance Basin. The objectives of this association could include but are not limited to:

(1) Provide an avenue for coordination between involved companies and agencies to prevent duplication of required efforts in compliance with environmental stipulations of the Oil Shale Lease.

(2) Initiate a team effort to identify adverse impacts and mitigation of cumulative consequences to the wildlife resource from development.

For example, Environmental Stipulations on the lease require each lessee to monitor and mitigate impacts caused by their actions to the wildlife resource. This indicates, in theory, that each company would be required to monitor and mitigate mule deer/vehicle accidents. Instead of each company performing the same efforts, the Association could develop a cooperative agreement between the companies to divide up equal segments of the major road segments and assign individual companies to monitor them. This data could then be compiled together to evaluate mule deer/vehicle accidents on a large scale basis over the entire area impacted.

This example would also apply to other cumulative impacts where the actions of each company contribute to, but are not solely responsible for, the impacts. Once these impacts have been identified they can also be mitigated in a similar cooperative fashion.

(3) Establish a trust fund to finance field surveys, research projects and mitigation efforts. This would equally distribute costs among com-

panies involved when monitoring and attempting to mitigate cumulative impacts.

(4) Allow interchange of equipment, technology and information between companies for monitoring and mitigation of impacts to the wildlife resource.

Implementation of uncommitted mitigation would reduce the amount of poaching which occurs during travel of employees to and from work. Mass transportation of employees would decrease the total quantity of vehicle/wildlife accidents, especially noticeable for mule deer. Improved technology and better coordination of mitigation efforts from establishment of an industrial association would significantly reduce site specific and cumulative impacts to the wildlife resource from oil shale, multiple mineral, and other energy development in Piceance Basin.

Cultural Resources -- A monitoring program to observe the effects of subsidence on cultural resources could provide data which could be used to protect cultural sites in the future.

Paleontological Resources -- To further evaluate the quality and extent of the paleontological resources in the area, it is recommmended that an intensive paleontological survey, especially of Tongue 5 of the Uinta Formation, should be conducted to locate small, hard to see, insect and rare plant fossils, along with the larger vertebrate fossils.

Recreation -- Assure continued hunter access along the Yellow Creek Jeep Trail. This would allow recreation access to a large area of hunting outside of the tracts that might otherwise be closed by leasing Tract C-18.

Socioeconomic -- Many actions can be taken to alleviate economic impacts. They take two primary forms: timely announcement, and coordination of plans and financial assistance.

Preparation for economic impacts requires lead time. Local governments, highway departments, etc. must be informed of new plans and changes in plans by companies and federal agencies sufficiently far in advance to allow construction of additional facilities ahead of the demand (or cancellation of the preparations before they are irretrievably committed). Likewise, timing of federal actions so that they do not occur at the same time as other large private or public developments would keep local population growth rates from becoming excessive.

Numerous steps can be taken to provide financial assistance, but many would require legislation. Measures to allow prepayment of ad valorem taxes, raise severance taxes, share revenues between benefitting and impacted jurisdictions, and require impact assistance by private industry would provide front-end funding for capital improvements and ease pressures on operating budgets. Federal aid programs could be increased, and jurisdictions at all levels could augment the private capital resources available for local housing and business investment.

All of these efforts will be more effective when they are carried out cooperatively by all the public and private interests involved.

Social impacts are more difficult to mitigate, however, some potential measures are recommended: under some conditions, provision for housing especially for single transient workers can be made near a mine site through a trailer park including recreational vehicle spaces (if state or county policies permit). In such instances, adequate eating and recreational facilities would need to be included.

Social services agencies typically have low priority in funding, but these are among the most important mitigators. In western Colorado, these agencies have formed county and Regional Human Resources Councils aimed at identifying local human services needs, gaps in fulfillment of these, sharing ideas for better ways of serving their communities, and obtaining funding especially in the face of cuts in federal monies. Communities could call on these councils and their member agencies for information and guidance in meeting services delivery needs, and could be more strongly committed to funding these less tangible but no less essential services along with allotting money for the more visible needs such as street paving and sewer expansion.

Efforts could be made to identify and welcome new arrivals to the communities (for instance, through cooperation with hiring officials), and to get them involved in community activities, particularly housewives, to counter the loneliness and isolation typical of new citizens. Some northwest Colorado Human Resources Councils have put together community resources booklets for distribution to newcomers and these help new families become socially oriented. A social outreach program has been started in Garfield County and this type of project is very helpful. Churches and clubs have many opportunities to encourage participation and otherwise to make transients and new residents feel at home.

As identified earlier, energy development produces both winners and losers. An effort must be made to identify these groups. Communities could then examine the social change processes and, understanding these, could seek to direct them so as to minimize adverse impacts and maximize benefits.

Additional measures recommended for dealing with boom growth are identified in the *Green River-Hams Fork Final Coal EIS* (1980).

Transportation -- Increased traffic congestion, accidents, property loss and damage costs could all be reduced if transportation, other than highway trucking were utilized. Other systems include overland conveyors, railroads and pipelines. If a highway trucking system is utilized the above effects could be minimized by increasing the capacity of existing roads. A combination of transportation systems would probably be most effective. For example, shipping all shale oil and liquids by pipeline, shipping all sodium and alumina minerals by rail and increasing road traffic capacity between Rifle and Rio Blanco and Rio Blanco and the proposed tracts.

Noise -- Noise from increased truck traffic could be reduced if other means of transportation were utilized. Other systems include overland conveyors, railroads and pipelines. Obviously, these other forms of transportation would create their own noise and the effects would depend upon the locations. From a noise emission standpoint, a slurry pipeline would be preferred.

Existing Rights -- Mine facilities should be designed to minimize impacts to existing rights-of-way, public water reserves, and oil and gas leases.

Surface Reclamation and Solid Waste Disposal -- Studies should be conducted on how the retort process can effectively be used to decrease toxicity of shale wastes and thereby decrease reclamation costs and monitoring. An economic assessment should also be conducted to compare the cost of backfilling and compaction with the costs of obtaining enough plant growth material to cover surface waste disposal piles and the cost of the additional reclamation area.

CHAPTER V

CONSULTATION AND COORDINATION

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CONSULTATION AND COORDINATION

In the course of preparing this analysis, several other agencies at all levels of government were consulted formally and informally. The following is a brief discussion of those efforts, and the results.

Formal Consultation

This is consultation that is required by regulations to formally involve agencies with specific expertise in the environmental impact statement process. At this level of analysis, most of these requirements do not apply, since a specific project development is not proposed. Steps will be taken to secure formal consultation on floodplains, water resources, wetlands, and cultural resources at the time the detailed development plan is submitted to the Minerals Management Service after any leasing of tracts takes place.

Interagency consultation was initiated with the U.S. Fish and Wildlife Service (USFWS) for threatened and endangered species based on the requirements of the Endangered Species Act. BLM has submitted a biological assessment based on the USFWS list of threatened and endangered species which occur on or near the project area. BLM has not received a biological opinion yet, but telephone conversations with USFWS personnel indicate that a decision has been made that oil shale leasing would not affect threatened and endangered species or their habitat. However, development of these leases have the potential of impacting the endangered Colorado squawfish in the White River. USFWS provided a recommendation that additional interagency consultation be required when the detailed development plan is submitted and anytime thereafter if significant modifications of the detailed desvelopment plan occur. This recommendation was included as committed mitigation.

Consultation with the SCS was completed for prime and unique farmlands via telephone conversation. Information from the Soil Survey of Rio Blanco County Area (SCS 1982, in press) indicating that no prime or unique farmlands are present within the tract boundaries was discussed with the State Conservationist. Based on this, SCS made a recommendation that a statement be included stating the absence of prime and unique farmlands and document the data source. This statement is included and this action has been determined by SCS to adequately fulfill the consultation requirements for this resource.

Consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation is currently being initiated.

Coordination

The State of Colorado has been involved from the beginning of the process in reviewing the alternatives to be addressed, providing scoping comments and reviewing portions of the analysis. In addition to the State Clearinghouse, several individual agencies were involved, and are listed in the Distribution List at the beginning of this document.

Rio Blanco County has been involved as well, including the County Commis sioners being briefed on the alternatives to be addressed, staff reviewing of portions of the analysis, and participation in the scoping process.

The Minerals Management Service, Oil Shale Office in Grand Junction, Colorado, has provided valuable technical assistance and review throughout the process. They will continue to be consulted on the technical aspects of oil shale development and its consequences.

The Regional Oil Shale Team, an advisory group comprised of representatives of the governors of the oil shale states (Colorado, Wyoming and Utah) and the BLM State Directors of those states, formally reviewed the alternatives to be assessed and recommended their approval by the Bureau. They will continue to provide an advisory role through the remainder of the process.

Other federal agencies have been contacted throughout the process, and their review of the Draft EIS will be solicited. These agencies are listed in the Distribution List at the beginning of this document.

Scoping

On February 24, 1982, a Federal Register notice was issued, announcing public scoping meetings and requesting written comments on the scope of the EIS within 30 days. Several letters were received from organizations and individuals identifying issues that should be addressed in the document. In addition, public meetings were held in Meeker,

Colorado on March 24, 1982, Grand Junction on March 25, 1982, and Denver on March 26, 1982.

The results of these meetings were primarily in the form of issues and concerns presented by the public, and these have been summarized and listed in Chapter I, Issues and Concerns. Both those issues that have been addressed, and those that were beyond the scope of the document are listed.

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APPENDIX A

OIL SHALE LEASE
AND
ENVIRONMENTAL STIPULATIONS

APPENDIX A

OIL SHALE LEASE AND ENVIRONMENTAL STIPULATIONS

In consideration of the mutual promises, terms and conditions contained herein, and the grant made hereby, this lease is entered into on ______ , to be effective on __________, _____, (hereinafter called the "Effective Date"), by the United States of America (hereinafter called the "Lessor"), acting through the Bureau of Land Management (hereinafter called the "Bureau") of the Department of the Interior (hereinafter called the "Department"), and (hereinafter called the "Lessee"), pursuant and subject to the terms and provisions of the Mineral Leasing Act of February 25, 1920 (41 Stat. 437), as amended (30 U.S.C. Sec. 181-263) (hereinafter called the "Act"), and to the terms and conditions, and requirements (1) of all regulations promulgated by the Secretary of the Interior (hereinafter called the "Secretary") in existence upon the Effective Date specifically including, but not limited to, the regulations in 30 CFR part 231 and 43 CFR Part 23 and Group 3000, all of which are incorporated herein and, by reference, made a part hereof; and (2) of all regulations hereafter promulgated by the Secretary (except those inconsistent with any specific provisions of this lease other than regulations incorporated herein by reference), all of which shall be, upon their effective date, incorporated in and, by reference, made a part of this lease.

Section 1. Definitions. As used in this lease:

(a) "Oil Shale" means a fine-grained sedimentary rock containing: (1) organic matter which was derived chiefly from aquatic organisms or waxy spores or pollen grains, which is only slightly soluble in ordinary petroleum solvents, and of which a large proportion is distillable into synthetic petroleum, and (2) inorganic matter which may contain other minerals. This term is applicable to any argillaceous, carbonate, or siliceous sedimentary rock which, through destructive distillation will yield synthetic petroleum. The products of Oil Shale include both shale oil and other minerals;

(b) "Leased Lands" means ______________________________ situated in the County of ____________, State of containing __________ acres, more or less;

(c) "Leased Deposits" means all deposits of Oil Shale lying within or under the Leased Lands;

(d) "Anniversary Date" means the anniversary of the Effective Date of this lease; however, if operations under this lease are suspended pursuant to section 39 of the Act (30 U.S.C. Sec. 209), the next Anniversary Date of this lease after the suspension shall follow the previous Anniversary Date by a period of time equal to the sum of one year and the period of suspension, and subsequent Anniversary Dates will be measured from that Anniversary Date;

(e) "Lease Year" means the period of time between two successive Anniversary Dates of this lease;

(f) "Ton" means a measure of weight of 2,000 pounds avoirdupois;

(g) "Mining Supervisor" means the appropriate mining supervisor of the United States Minerals Management Service defined as the U. S. Geological Survey in 30 CFR 231.2(c); and

(h) "Commercial Quantities" means quantities sufficient to provide a return after all variable costs of production have been met.

Section 2. Grant to Lessee. The Lessee is hereby granted, subject to the terms of this lease, the exclusive right and privilege to prospect for, mine by underground or surface means and process by retorting or by *in-situ* methods

or otherwise, as he may reasonably choose, and in accordance with approved plans utilize and dispose of all Leased Deposits together with the right to construct on the Leased Lands all such works, buildings, plants, structures, roads, powerlines, and additional facilities as may be necessary or reasonably convenient for the mining, processing, and preparation of products of the Leased Deposits for market and the housing and welfare of the Lessee's employees, agents, and contractors, and to use so much of the surface of the Leased Lands as may reasonably be required in the exercise of the rights and privileges herein granted.

Section 3. Lessor's Reserved Interests in the Leased Lands. The Lessor reserves the following:

(a) The right to lease, sell, or otherwise use or dispose of the surface of the Leased Lands or of any surface or mineral resource in the Leased Lands (or of any interest therein) under existing laws or laws hereafter enacted, subject to the rights of the Lessee under this lease;

(b) The right, upon such terms as it may determine to be just, to permit for joint or several use, such easements or rights-of-way, including easements in tunnels upon, through, or in the Leased Lands, as may be necessary or appropriate to the working of the Leased Lands or other lands containing mineral deposits subject to the Act, and the treatment and shipment of the products thereof by or under authority of the Lessor, its Lessees, or permittees, and for other public purposes; and

(c) The right to conduct and to authorize geological and other investigations on the Leased Lands which do not interfere with or endanger operations under this lease.

Section 4. Lease Term. This lease shall be for a period of 20 Lease Years from the Effective Date and so long thereafter as there is production from the Leased Deposits in commercial quantities, subject to the provisions of section 23 with respect to the readjustment of terms and conditions and the right of the parties to terminate the lease.

Section 5. Bonus. In addition to all other payments required hereunder, the Lessee shall pay to the Lessor the amount of $_____ as a bonus. This bonus shall be due and payable in five installments as follows: Receipt of $_______ at the time of the sale as the first installment is hereby acknowledged by the Lessor; the balance shall be paid in four equal annual installments of $______ due and payable on each of the first four Anniversary Dates of this lease. In the event the Secretary accepts a surrender or relinquishment of this lease filed by the Lessee at any time prior to the third Anniversary Date, the Lessee shall be released from any obligation to pay the fourth and fifth bonus installments required hereunder. That release shall not relieve the Lessee of the obligation to pay installments which had accrued prior to the filing of the surrender or relinquishment of the lease, but had not been paid prior to the Secretary's acceptance of that surrender or relinquishment. The Lessee may credit against the fourth bonus installment any expenditures prior to the third Anniversary Date directly attributable to operations under this lease on the Leased Lands for the development of the Leased Deposits, but not any expenditures attributable to the preparation of a development plan under section 10 of this lease. Upon the credit of an expenditure, the Lessee shall be relieved of the duty of paying the equivalent amount of the fourth bonus installment. Similarly, the Lessee may credit against the fifth bonus installment any expenditures prior to the fourth Anniversary Date directly

attributable to operations under this lease on the Leased Lands for the development of the Leased Deposits and not credited against the fourth bonus installment, but not any expenditures attributable to the preparation of a development plan under section 10. Upon the credit of an expenditure, the Lessee shall be relieved of the duty of paying the equivalent amount of the fifth bonus installment. The Mining Supervisor shall have the duty of determining whether expenditures credited by the Lessee are properly attributable to such operations, and, if the Mining Supervisor determines that any reported expenditure is not attributable to such operations, the Lessee shall not receive credit for that expenditure.

Section 6. Rentals. The Lessee shall pay the Lessor an annual rental which shall be in the amount of 50 cents for each acre or fraction of an acre of the Leased Lands. The Lessee shall pay the rental for each subsequent Lease Year on or before the first day of that Lease Year. Rentals for any Lease Year shall be credited by the Lessor against any royalty payments for that Lease Year.

Section 7. Royalties.

(a) The Lessee shall pay to the Lessor a royalty on all Oil Shale extracted by the Lessee from the Leased Lands which is either processed or sold by the Lessee. The royalty on Oil Shale shall be computed separately for shale oil and for other minerals as follows:

(1) The royalty on shale oil shall be computed on the basis of the shale oil content of the Oil Shale; the method of computing the royalty shall depend upon whether the Oil Shale is extracted by mining methods or processed by in situ methods.

(i) If the Oil Shale is extracted by mining methods, the Lessee shall pay the Lessor a basic royalty rate of 12 cents on every Ton of Oil Shale which the Lessee either processes under the Lease either on or off the Leased Lands or sells prior to processing. This basic royalty rate shall be subject to the following adjustments:

(A) If the shale oil content of the Oil Shale mined is less than 30 gallons per Ton, the basic royalty rate per Ton of Oil Shale shall be reduced by one cent for each gallon or fraction thereof that the shale oil content is less than 30 gallons per Ton, but in no event shall the royalty rate be less than four cents per Ton. If the shale oil content of the Oil Shale mined is more than 30 gallons per Ton, the basic royalty rate per Ton shall be increased by one cent for each gallon or fraction thereof that the shale oil content is more than 30 gallons per Ton.

(B) The royalty rate determined under (A) above shall be adjusted by an increase or decrease of the same percentage as the Producer's Price Index for crude petroleum from the latest index immediately preceding the month for which royalties are due as compared with the Domestic Wholesale Price Index for crude oil for March 1974. However, in no event shall the basic royalty rate for shale oil be decreased to less than 4 cents on every Ton of Oil Shale mined under the lease.

(C) The shale oil content of the Oil Shale shall be determined either by the Modified Fischer Assay method or by such other method as the Lessor and the Lessee adopt, and the royalty shall be based on the monthly average of shale oil content of all Oil Shale processed under this lease or transferred from the Leased Lands for processing or sale by the Lessee. Computations of quantities, assays and royalties shall be rounded to the nearest hundredth, or within the limits of the standard deviation for commercial testing equipment as approved by the Mining Supervisor.

(ii)(A) If the Oil Shale is processed by in situ methods, royalty shall be paid at a basic royalty rate of 12 cents per Ton. The number of Tons processed shall, for purposes of computing royalty, be determined by: (I) establishing through calorimetric tests designated by the American Society for Testing and Materials as "Standard" or "Tentative," the total gross heat of combustion in BTUs of all oil and gas products from retorting prior to treatment, adjusted downward by the total gross heat of combustion in BTUs of combustible fluids (gases or liquids) injected as heat carriers, but not for fuel purposes, into the formation being processed; (II) dividing the adjusted total gross heat of combustion in BTUs by 152,700 BTUs (shale oil and gas recovered by Modified Fischer Assay of Oil Shales, containing approximately 30 gallons of shale oil per Ton, has a heating value of 152,700 BTUs per gallon of shale oil and associated gas), to arrive at the equivalent number of gallons of shale oil produced; and (III) dividing the equivalent number of gallons of shale oil produced by 30, to arrive at the number of Tons of Oil Shale processed by in situ methods.

(B) The basic royalty rate applicable to shale oil from Oil Shale process by in situ methods shall be adjusted in the same manner as that provided in paragraph (a)(1)(i)(B) of this section for the adjustment of the basic royalty rate applicable to shale oil processed from Oil Shale extracted by mining methods.

(C) Computations of quantities, assays, and royalties relating to tonnage of Oil Shale shall be determined by the same standards as used under Section 7(a)(1)(i)(C).

(2) The Lessee shall also pay a royalty on all minerals, other than shale oil, contained in Oil Shale produced from the Leased Deposits which the Lessee processes, either on or off the Leased Lands, or sells; except that no royalty shall be required where the Lessee demonstrates to the satisfaction of the Mining Supervisor that the cost of producing the mineral exceeds the gross value at the point of shipment to market, and that the mineral was processed only as a consequence of the Lessee's need to comply with the Oil Shale Lease Environmental Stipulations. This royalty shall be computed on the basis of the gross value of the other minerals at the point of shipment to market, and shall be at a rate of 3 per centum for the first ten Lease Years, 4 per centum for the eleventh year through the fifteenth Lease Year, and 5 per centum beginning with the sixteenth Lease Year.

(b) The Lessee shall determine accurately, on the Leased Lands, the weight or quantity and quality of all Oil Shale produced from the Leased Deposits by each method used and shall enter the weight or quantity and quality thereof accurately in books which shall be kept and preserved by the Lessee for such purposes.

(c) Payments for royalties due under this lease shall be payable monthly on or before the last day of the calendar month following the calendar month in which the Oil Shale is processed or, if it is not processed, is sold.

(d) If the Lessee shall show that compliance with the requirements for environmental protection prescribed in the detailed development plan (or amended, supplemental, or partial plan) required under section 10 of this lease, and as approved in accordance with the regulations in 43 CFR Part 23 and 30 CFR Part 231, now or hereinafter in force, or imposed by legislation enacted after the effective date of that plan (or of an amendment or supplement to that plan), has engendered or will engender extraordinary costs in an amount which is in excess of those in the contemplation of the parties, as determined by the Lessor, on the effective date of that plan (or amendment or supplement to that plan), and the Secretary, if he deems it desirable, may,

in order to offset such costs, adjust the royalties that would otherwise become due and payable thereafter under subsection (a) of this section by allowing a credit against those royalties in such an amount, and for such a time as he determines is warranted in the circumstances.

(e)(1) For the sixth and each succeeding Lease Year the Lessee shall pay a minimum royalty which, to the extent that royalties on production during that Lease Year in that amount have not been previously paid, shall be due and payable on the Anniversary Date at the end of that Lease Year. For the sixth Lease Year, the Lessee's minimum royalty shall be equal to the royalty due on shale oil under subsection (a)(1)(i) of this section on an annual production rate of ____________ Tons of Oil Shale containing ________ gallons of shale oil per Ton of Oil Shale. The annual production rate for computing minimum royalty for each subsequent Lease Year up to and including the fifteenth Lease Year shall increase in an amount of _________ Tons of Oil Shale per year for each subsequent Lease Year; for the fifteenth and each subsequent Lease Year the annual rate shall be ________ Tons of Oil Shale. The Secretary may excuse the Lessee from compliance in whole or in part, with the requirements of this paragraph (1) of subsection (e) during any year in which the Lessee is prevented by circumstances over which he has no control from implementing a development plan submitted under Section 10 of this lease.

(2) The Lessee may credit against any minimum royalty due on the sixth Anniversary Date or any subsequent Anniversary Date up to and including the tenth Anniversary Date the amount of any expenditures which are made between the approval of the development plan under Section 10 of this lease and the tenth Anniversary Date and which are directly attributable to operations on the Leased Lands pursuant to that development plan for the development of the Leased Deposits and which were not credited against the fourth and fifth bonus installments. The Mining Supervisor shall have the duty of determining whether expenditures credited by the Lessee are attributable to such operations, and, if the Mining Supervisor determines that any reported expenditure is not attributable to such operations, the Lessee shall not receive credit for the expenditure. Upon the credit of an expenditure against the minimum royalty due, the Lessee will be relieved of the duty of paying the equivalent amount of minimum royalty: Provided, however, That, if there is actual production in the sixth or any subsequent Lease Year, the Lessee shall not be permitted to credit expenditures against the first $10,000 of minimum royalty due for that Lease Year.

(f) If the Lessee enters into production prior to the eighth Anniversary Date, and the royalty due in the eighth or any previous Lease Year exceeds the minimum royalty due under subsection (e)(1) of this section for that Lease Year, the Lessee shall be relieved from the payment of one-half of the difference between the actual royalty due for that Lease Year and the figure set in subsection (e)(1) for minimum royalty due for that Lease Year. This relief from the payment of royalty shall be in addition to any crediting of expenditures under subsection (e)(2) of this section, but no crediting of expenditures against minimum royalty shall reduce the figure for minimum royalty used in the preceding sentence.

Section 8. Payments. All bonus installments shall be paid to the appropriate State Office of the Bureau. All rental payments shall be made to the appropriate State Office of the Bureau until this lease enters a producing status or minimum royalty is required to be paid on it; thereafter the rentals and royalties shall be paid to the appropriate Mining Supervisor with whom all reports (including any reports on expenditures deductible under section 5)

concerning operations under the lease shall be filed. All remittances to the Bureau shall be made payable to the Bureau of Land Management; those to the Minerals Management Service shall be made payable to the United States Minerals Management Service.

Section 9. Bond.

(a) The Lessee shall file with the appropriate Bureau office and maintain a bond in the amount of $40,000 (adjusted periodically to reflect the prevailing rise in cost of living) for the purpose of ensuring compliance with the provisions of this lease, except those provisions for compliance with which a separate bond is required under subsection (b) of this section.

(b)(1) Upon approval of a detailed development plan under section 10 of this lease, the Lessee shall file with the appropriate Bureau office and maintain, in addition to the bond required under subsection (a) of this section, a bond (in an amount determined pursuant to paragraph (2) of this subsection) which shall be conditioned upon the faithful compliance with the regulations in 30 CFR Part 231 and 43 CFR Part 23, the provisions of sections 10 and 11 of this lease, the Oil Shale Lease Environmental Stipulation attached to this lease pursuant to section 11, and any approved development plan (or approved, amended, supplemental or partial plan), to the extent that it relates to the preservation and protection and conservation of resources other than Oil Shale during the conduct of exploration or mining operations, and the reclamation of lands and waters affected by exploration or mining operations.

(2) During the first three Lease Years after the approval of detailed development plan under section 10 of this lease, the bond shall be in an amount equal to (i) $4,000 per acre for all portions of the Leased Lands which, pursuant to the plan, will be used for spent shale disposal sites and sites for actual mining operations during that three year period and (ii) $1000 per acre for all other portions of the Leased Lands upon which operations will be conducted or which will be directly affected by operations during that three year period under the plan, but the total bond shall in no event be less than $40,000. After the first three Lease Years the bond shall be renewed at intervals of three Lease Years. Each renewed bond shall be for three Lease Years and at such a total figure as shall be determined by the Mining Supervisor to be needed to provide for the reclamation and restoration of all portions of the Leased Lands which have been affected by previous operations under this lease or which will be affected by operations under this lease during the ensuing three year period. The amount of the bond shall be increased at any time during the three-year period at the demand of the Mining Supervisor if there is a change in the development plan which, in the opinion of the Mining Supervisor increases the possibility of environmental damage. Upon request of the Lessee, the bond may be released as to all or any portion of the Leased Lands affected by exploration or mining operations during the three year period covered by the bond when the Lessor has determined that the Lessee has successfully met the reclamation requirements of the approved development plan and that operations have been carried out and completed with respect to these lands in accordance with the approved plan.

(c) Prior to the approval of any plan for exploratory work under section 10(d) of this lease, the Lessee shall file with the appropriate Bureau office and maintain, in addition to the bond required under subsection (a) of this section, a bond in such an amount as the Mining Supervisor shall require, but in no event less than $40,000, which shall be conditioned upon the faithful compliance with regulations in 30 CFR Part 231 and 43 CFR Part 23, the

provisions of sections 10 and 11 of this lease, the Oil Shale Lease Environmental Stipulations attached to this lease pursuant to section 11, and any approved plan for exploratory work, to the extent that it relates to the preservation and protection of the environment (including land, water, and air), the protection and conservation of resources other than Oil Shale during the conduct of exploration operations, and the reclamation of lands and waters affected by exploration operations. The bond required by this subsection shall apply only to actions taken prior to the date of approval of the development plan under section 10(a) of this lease. However, with the consent of the Mining Supervisor, the Lessee may modify this bond in such a manner as is necessary to meet the requirements of subsection (b) of this section, and the bond so modified may, with the consent of the Mining Supervisor, be maintained as the bond required under subsection (b).

Section 10. Development Plan and Diligence Requirements.

(a) The Lessee shall file with the Mining Supervisor on or before the third Anniversary Date a detailed development plan. This plan shall include: (1) a schedule and description of the planning, exploratory, development, production, processing, reclamation, and monitoring operations and all other activities to be conducted under this lease; (2) a detailed description pursuant to 30 CFR Part 231 and 43 CFR Part 23 of the procedures to be followed to assure that the development plan, and lease operations thereunder, will meet and conform to the environmental criteria and controls incorporated in the lease and make use of best available environmental control technology; and (3) a requirement that the Lessee use all due diligence in the orderly development of the Leased Deposits, and, in particular, to attain, at as early a time as is consistent with compliance with all the provisions of this lease, production at a rate at least equal to the rate on which minimum royalty is computed under section 7(e)(1).

Prior to commencing any of the operations under the development plan in the Leased Lands, the Lessee shall obtain the Mining Supervisor's approval of the development plan. The Mining Supervisor shall not delay unnecessarily in the consideration of a development plan, but he shall take time to consider both technical and environmental provisions of the plan thoroughly prior to approval, and shall hold public hearings on the environmental provisions to assist him in his consideration of the detailed development plan. If the development plan submitted by the Lessee is unacceptable, the Mining Supervisor shall inform the Lessee by written notice of the reasons why the development plan is unacceptable and shall give him an opportunity to amend the plan. If an acceptable development plan is not submitted to the Mining Supervisor by the Lessee within one year after the Lessee's receipt of that notice, the Mining Supervisor shall send a second written notice to the Lessee concerning the unacceptability of the development plan. A failure by the Lessee to submit an acceptable plan within one year after his receipt of the second written notice, without reasonable justification for delay, shall be grounds for termination of the lease, if the Lessor so elects.

Upon approval of the plan, the Lessee shall proceed to develop the Leased Deposits in accordance with the approved plan. After the date of approval of the development plan, the Lessee shall conduct no activities upon the Leased Lands except pursuant to that development plan, or except for necessary activities following a relinquishment under section 28 of this lease or for the disposition of property after termination pursuant to section 32 of this lease.

(b) The Lessee must obtain the written approval of the Mining Supervisor of any change in the plan approved under subsection (a).

(c) The Lessee shall file with the Mining Supervisor annual progress reports describing the operations conducted under the development plan required under subsection (a).

(d) Prior to undertaking any exploratory work on the Leased Lands between the Effective Date and the date of approval of the detailed development plan required by subsection (a) of this section, the Lessee shall file with the Mining Supervisor a plan showing the exploratory work which he proposes to undertake and he shall not commence that work until the Mining Supervisor has approved the plan.

Exploratory work, as used in this subsection, shall include, but not be limited to, seismic work, drilling, blasting, research operations, cross-country travel, the construction of roads and trails and other necessary facilities and the accumulation of environmental baseline data required under section 1(C) of the Oil Shale Lease Environmental Stipulations. Prior to approval of the detailed development plan under subsection (a) of this section, all exploratory work on the Leased Lands shall be conducted pursuant to a plan approved under this subsection.

Section 11. Protection of the Environment; additional stipulations.

(a) The Lessee shall conduct all operations under this lease in compliance with all applicable Federal, State, and local water pollution control, water quality, air pollution control, air quality, noise control, and land reclamation statutes, regulations, and standards.

(b) The Lessee shall avoid, or, where avoidance is impracticable, minimize and, where practicable, repair damage to the environment, including the land, the water and air.

(c) The Oil Shale Lease Environmental Stipulations are attached to and specifically incorporated in this lease. A breach of any term of these stipulations will be a breach of the terms of this lease and subject to all the provisions of this lease with respect to remedies in case of default.

Section 12. Operations on the Leased Lands; Water Rights.

(a) The Lessee shall exercise reasonable diligence, skill, and care in all operations on the Leased Lands. The Lessee's obligations shall include, but not be limited to, the following:

(1) The Lessee shall conduct all operations on the Leased Lands so as to prevent injury to life, health, or property.

(2) The Lessee shall avoid, or where avoidance is impracticable, minimize and, where practicable, correct hazards to the public health and safety related to his operations on the Leased Lands.

(3) The Lessee shall avoid wasting the mineral deposits, and other resources, including but not limited to, surface resources, which may be found in, upon, or under such lands.

(b) The Lessee shall conduct all operations on the Leased Lands whether they are surface or underground operations, and whether they are in lands in which the Lessor owns the surface or those in which the Lessor has disposed of the surface, in accordance with the provisions of 30 CFR Part 231 and 43 CFR Part 23. Both 30 CFR Part 231 and 43 CFR Part 23 are specifically incorporated by reference into the provisions of this section. The provisions of 43 CFR Part 23 are hereby expressly made applicable to the Lessee's underground mining operations with equal force and effect to that given to those provisions in their application to surface mining operations and to operations on lands in which the Lessor owns the surface.

(c) The Lessee shall take such reasonable steps, and shall conduct operations in such a manner, as may be needed to avoid or, where avoidance is impracticable, to minimize and, where practicable, repair damage to: (1) any forage and timber growth on Federal or non-Federal lands in the vicinity of the Lease Lands; (2) crops, including forage, timber, or improvements of a surface owner; or (3) improvements, whether owned by the United States or by its permittees, licensees, or lessees. The Mining Supervisor must approve the steps to be taken and the restoration to be made in the event of the occurrence of damage described in this subsection.

(d) All water rights developed by the Lessee through operation on the Leased Lands shall immediately become the property of the Lessor. As long as the lease continues, the Lessee shall have the right to use those water rights free of charge for activities under the lease.

Section 13. Development by In Situ Methods. Where in-situ methods are used for development of Oil Shale, the Lessee shall not place any entry, well, or opening for such operations within 500 feet of the boundary line of the Leased Lands without the permission of, or unless directed by, the Mining Supervisor, nor shall induced fracturing extend to less than 100 feet from that boundary line.

Section 14. Nuclear Fracturing. No nuclear explosive may be detonated on or in the Lease Lands without the express written approval of the Secretary. The Secretary may approve the detonations of such explosives only after the preparation of an environmental impact statement pursuant to section 102(2)(C) of the National Environmental Policy Act of 1969 (42 U.S.C. Sec. 4332(2)(C)).

Section 15. Inspection and Investigation. The Lessee shall permit any duly authorized officer or representative of the Department at any reasonable time: To inspect or investigate the Leased Lands and all surface and underground improvements, works, machinery, and equipment, and all books and records pertaining to operations and surveys or investigations under this lease; and copy and make extracts from any books and records pertaining to operations under this lease.

Section 16. Reports, Maps, etc.

(a) At such times and in such a form as the Mining Supervisor may prescribe the Lessee shall furnish a report with respect to investment and operating costs under this lease. The Lessee shall also submit to the Mining Supervisor in such form as the latter may prescribe, not more than 60 days after the end of each quarter of the Lease Year, a report covering that quarter which shall show the amount of each respective mineral or product produced from the Leased Deposits by each method of production used during the quarter, the character and quality thereof, the amount of products and by-products disposed of and price received therefor, and the amount in storage or held for sale. This report shall be certified by the superintendent of the mine, or by some other agent having personal knowledge of the facts who has been designated by the Lessee for that purpose.

(b) The Lessee shall submit to the Mining Supervisor at such times and in such form as the Mining Supervisor may prescribe, operational data, including but not limited to, raw and processed oil shale analysis, flow rates and analysis of solid, liquid, and gaseous streams.

(c) The Lessee shall prepare and furnish at such times and in such form as the Mining Supervisor may prescribe, maps, photographs, reports, statements and other documents, required by the provisions of 30 CFR Part 231 and 43 CFR Part 23.

Section 17. Notice. Any notice which is required under this lease shall be given in writing. Where immediate action is required, notice may be given orally or by telegram, but, where this is done, the oral notice shall be confirmed in writing. Wherever this lease requires the Lessee to give notice, notice shall be given to the Mining Supervisor unless this lease requires that notice be given to another officer. The Lessee shall inform the Bureau State Office and the Mining Supervisor of the Lessee's officer to whom notice shall be given.

Section 18. Employment Practices. The Lessee shall pay all wages due persons employed on the Leased Lands at least twice each month in lawful money of the United States. The Lessee shall grant all miners and other employees complete freedom of purchase. The Lessee shall restrict the workday to not more than 8 hours in any one day for underground workers, except in cases of emergency. The Lessee shall employ no person under the age of 16 years in any mine below the surface. If the laws of the State in which the mine is situated prohibit employment, in a mine below the surface, of persons of an age greater than 16 years, the Lessee shall comply with those laws.

Section 19. Equal Opportunity Clause; certification of non-segregated facilities.

(a) Equal Opportunity Clause. During the performance of this lease the Lessee agrees as follows: (1) The Lessee shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Lessee shall take affirmative action to insure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Lessee shall post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Lessor setting forth the provisions of this Equal Opportunity clause.

(2) The Lessee shall, in all solicitations or advertisements for employees placed by or on behalf of the Lessee, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(3) The Lessee shall send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the Lessor, advising the labor union or workers' representative of the Lessee's commitments under this Equal Opportunity clause, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The Lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and of the rules regulations and relevant orders of the Secretary of Labor.

(5) The Lessee shall furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, as amended, and by the rules,

regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the Secretary of the Interior and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the Lessee's noncompliance with the Equal Opportunity clause of this lease or with any of the said rules, regulations, or orders, this lease may be canceled, terminated or suspended in whole or in part and the Lessee may be declared ineligible for further Federal Government contracts or leases in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, as amended, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, as amended, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(7) The Lessee shall include the provisions of Paragraphs (1) through (7) of this subsection (a) in every contract, subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, as amended, so that such provisions will be binding upon each contractor, subcontractor or vendor. The Lessee shall take such action with respect to any contract, subcontract or purchase order as the Secretary may direct as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, That in the event the Lessee becomes involved in, or is threatened with, litigation with a contractor, subcontractor or vendor as a result of such direction by the Secretary, the Lessee may request the lessor to enter into such litigation to protect the interests of the lessor.

(b) Certification of non-segregated facilities. By entering into this lease, the Lessee certifies that Lessee does not and shall not maintain or provide for Lessee's employees any segregated facilities at any of Lessee's establishments, and that Lessee does not and shall not permit Lessee's employees to perform their services at any location, under Lessee's control, where segregated facilities are maintained. The Lessee agrees that a breach of this certification is a violation of the Equal Opportunity clause in this lease. As used in this certification, the term "segregated facilities" means, but is not limited to, any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise. Lessee further agrees that (except where Lessee has obtained identical certifications from proposed contractors and subcontractors for specific time periods) Lessee shall obtain identical certifications from proposed contractors and subcontractors prior to the award of contracts or subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that Lessee shall retain such certifications in Lessee's files and shall make them available to the Secretary at his request; and that Lessee shall forward the following notice to such proposed contractors and subcontractors (except where the proposed contractor or subcontractor has submitted identical certifications for specific time periods): Notice to prospective contractors and subcontractors of requirements for certification of non-segregated facilities. A Certification of Non-segregated Facilities, as required by the May 9, 1967, order (32 FR 7439, May 19, 1967) on Elimination of Segregated Facilities, by

the Secretary of Labor, must be submitted prior to the award of a contract or subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each contract and subcontract or for all contracts and subcontracts during a period (i.e., quarterly, semi-annually, or annually).

Section 20. Taxes. The Lessee shall pay, when due, all taxes lawfully assessed and levied under the laws of the State or the United States upon improvements, output of mines, or other rights, property, or assets of the Lessee.

Section 21. Monopoly and Fair Prices. The lessor reserves full authority to promulgate and enforce orders and regulations under the provisions of sections 30 and 32 of the Act (30 U.S.C. Sec. 187 and 189) necessary to insure that any sale of the production from the Leased Deposits to the United States or to the public is at reasonable prices, to prevent monopoly, and to safeguard the public welfare, and such regulations shall, upon promulgation, be binding upon the Lessee.

Section 22. Suspension of Operations or Production. Any suspension of operations or production under section 39 of the Act (30 U.S.C. Sec. 209) granted with respect to this lease shall take effect as of the first day of the calendar month following the calendar month during which the suspension is approved, except that, in a situation where in the opinion of the Mining Supervisor there is an immediate danger to life, or of irreparable major damage to property or the environment, the Mining Supervisor may grant a suspension effective immediately. The term of any suspension granted pursuant to the Lessee's request with respect to operations or production under this lease shall be in full calendar months. A suspension shall terminate either at the time designated in the suspension order or, if there is no time of termination in the order, at such time as the Mining Supervisor shall designate in subsequent notice to the Lessee.

Section 23. Readjustment of Terms and Conditions. The Lessor may propose the reasonable readjustment of the terms and conditions of this lease (including royalty provisions), the first readjustment to be effective at the twentieth Anniversary Date of this lease and subsequent readjustments to be effective at twenty Lease Year intervals thereafter. At least 120 days before the appropriate Anniversary Date the Lessor shall give notice to the Lessee of any proposed readjustment of the terms and conditions of the lease and the nature thereof, and, unless the Lessee, within 60 days after receipt of such notice, files with the Lessor an objection to the proposed terms or relinquishes the lease as of the appropriate Anniversary Date, the Lessee shall be deemed conclusively to have agreed to such terms and conditions. If the Lessee files objections with the Lessor, and agreement cannot be reached between the Lessor and Lessee within a period of 60 days after the filing of the objections, the lease may be terminated by either party upon giving 60 days' notice to the other party; however, the Lessor's right to terminate the lease shall be suspended by the Lessee's filing of a notice of appeal pursuant to section 34 of this lease. If the Lessee files objections to the proposed readjusted terms and conditions, the existing terms and conditions (other than those concerning royalties) shall remain in effect until there has been an agreement between the Lessor and the Lessee on the new terms and conditions to be incorporated in the lease, or until the Lessee has exhausted his rights of

appeal under section 34 of this lease, or until the lease is terminated; however, the readjusted royalty provisions shall be effective until there is either agreement between the Lessor and the Lessee or until the lease is terminated. If the readjusted royalty provisions are subsequently rescinded or amended, the Lessee shall be permitted to credit any excess royalty payments against royalties subsequently due to the Lessor.

Section 24. Assignment. With respect to the assignment or transfer of any interest under this lease, the Lessee shall comply with the provisions of 43 CFR Subpart 3506 to the same extent as if that Subpart were specifically applicable to oil shale leases. The Lessor shall have no discretion to refuse to approve an assignment except: (1) where the assignee is not qualified to hold a lease under section 1 of the Act (30 U.S.C. Sec. 181); (2) where the assignee is unable to provide an adequate bond; or (3) where either the assigned or the retained portion of the lease would, in the opinion of the Lessor, be too small to be economically developed.

Section 25. Overriding Royalties. The Lessee shall not create, by assignment or otherwise, an overriding royalty interest in excess of 25 percent of the rate of royalty payable to the United States under this lease or an overriding royalty interest which when added to any other outstanding overriding royalty interest exceeds that percentage, except that, where an interest in the leasehold or in an operating agreement is assigned, the assignor may retain an overriding royalty interest in excess of the above limitation if he shows to the satisfaction of the Department that he has made substantial investments for improvements on the lands covered by the assignment.

Section 26. Heirs and Successors in Interest. Each obligation hereunder shall extend to and be binding upon, and every benefit shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Section 27. Unlawful Interest. No member of, or Delegate to, Congress or Resident Commissioner, after his election or appointment, either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of Section 3741 of the Revised Statutes of the United States (41 U.S.C. Sec. 22), as amended, and Sections 431, 432, and 433, Title 18 of the United States Code, relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

Section 28. Relinquishment of Lease.

(a) Upon showing to the satisfaction of the Lessor that he has complied with the terms and conditions of this lease, the Lessee may relinquish the entire lease or any legal subdivision of the Leased Lands.

(b) A relinquishment must be filed, in duplicate, in the proper Bureau State Office. Upon its acceptance it shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety, in accordance with the terms and conditions of this lease, (1) to make payment of all accrued bonus payments, rentals, and royalties, except as provided in section 5; (2) to provide for the preservation of any mines, *in-situ* production works, underground development works, other permanent improvements,

and other property, whether fixtures or personalty, on the Leased Lands; (3) to provide for the reclamation of lands and water affected by exploration or mining operations under this lease; and (4) to comply with all other applicable requirements of this lease.

Section 29. Remedies in Case of Default. If the Lessee shall fail to comply with any of the terms and conditions of this lease (including the terms and conditions of any development plan approved under section 10) and that default shall continue for a period of 30 days after service of notice thereof by the Mining Supervisor, the Mining Supervisor may suspend operations until the required action is taken to correct noncompliance, or the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Section 31 of the Act (30 U.S.C. Sec. 188) and for forfeiture of any applicable bond. If the Lessee fails to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or to prevent danger to the employees, or to avoid, or, where avoidance is impracticable, to minimize and, where practicable, repair damage to the environment, or, if immediate action by the Lessor, without waiting for action by the Lessee, is required for any of those purposes, the Lessor may enter on the premises and take such measures as he may deem necessary to prevent such loss, damage, or danger, or to correct the damaging, dangerous, or unsafe condition of the mine or any other facilities upon the Leased Lands, and those measures shall be at the expense of the Lessee.

Section 30. Effect of Waiver. A waiver of any breach of the provisions of this lease shall extend only to that particular breach and shall not limit the rights of the parties with respect to any future breach. A waiver of a particular cause of forfeiture shall not prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Section 31. Delivery of Premises in Case of Forfeiture. In case of the termination of this lease in any manner the Lessee shall deliver to the Lessor, in the condition required by the reclamation requirements of approved exploration and development plans, and subject to the provisions of section 32 of this lease, the Leased Lands, including permanent improvements and other property on the Leased Lands, whether affixed to the ground or movable and all underground shafts and timbering, well casing, and such other supports and structures as are necessary for the preservation of the Leased Lands, or any mines, other underground development works, or deposits in the Leased Lands.

Section 32. Disposition of Property upon Termination of Lease.

(a) Upon termination of this lease in any manner all underground timbering and any other supports or structures which the Lessor shall inform the Lessee are necessary for the preservation of any mines or other underground development works shall become and remain thereafter a part of the realty without the payment of any compensation to the Lessee. All other structures, equipment, machinery, tools, appliances, and materials on the Leased Lands, whether affixed to the ground or movable, shall remain the property of the Lessee upon the termination of this lease, but the Lessee shall have no right, for a period of six months following the termination, to remove from the Leased Lands any of that property which in the opinion of the Lessor is useful for the protection of the Leased Lands (including any mines in those lands) unless the Lessor shall expressly authorize the removal. During the six-month period

the Lessor shall have the right to purchase at the appraised value any or all items of that property required or useful for the protection of the Leased Lands. The appraised value shall be fixed by three disinterested and competent persons (one to be designated by the Lessor, one by the Lessee, and the third by the two so designated), and the appraised value determined by the three or a majority of them shall be conclusive.

(b) At any time within a period of 90 days after either the Lessor has informed the Lessee that he will not purchase the property or the expiration of the 6-month period, the Lessee shall have the right to remove from the premises the property which was not purchased by the Lessor.

(c) Any structures, machinery, equipment, tools, appliances, and materials, subject to removal by the Lessee as provided above, which are allowed to remain on the Leased Lands shall become the property of the Lessor on expiration of the 90-day period or any extension of that period which may be granted by the Lessor because of adverse climatic conditions or other good and sufficient reason, unless the Lessor shall direct the Lessee to remove any or all of such property on expiration of the 90-day period. If the Lessor directs the Lessee to remove such property, the Lessee shall do so at his own expense or, if he fails to do so within a reasonable period, the Lessor may do so at the Lessee's expense.

Section 33. Protection of Proprietary Information.

(a) This lease, and any activities thereunder, shall not be construed to grant a license, permit or other right of use or ownership to the Lessor, or any other person, of the patented processes, trade secrets, or other confidential or privileged technical information (hereafter in this section called "technical processes") of the Lessee or any other party whose technical processes are embodied in improvements on the Leased Lands or used in connection with the lease. Notwithstanding any other provision of this lease, the Lessor agrees that any technical processes obtained from the Lessee which are designated by the Lessee as confidential shall: (1) not be disclosed to persons other than employees of the Federal Government having a need for such disclosures; (2) not be copied or reproduced in any manner except as required specifically by the Mining Supervisor; and (3) not be used in any manner that will violate their proprietary nature unless the Mining Supervisor shall make a written determination that such technical processes do not contain trade secrets or are not confidential, or unless such disclosure is required by court order or statute; provided however, that before any such publication or disclosure, except where the overriding national interest demands otherwise, the Mining Supervisor shall notify the Lessee of the proposed disclosure and those to whom the disclosure will be made, provide a copy of the written determination and allow the Lessee 30 days to submit additional material supporting its claim of confidentiality or otherwise to initiate an appeal from the decision of the Mining Supervisor prior to any disclosure.

(b) In the event the lease is terminated and the Lessor elects pursuant to section 32 to purchase machinery or equipment the use of which would involve technical processes in the operations of the purchased machinery, the Lessor shall have the right to use those technical processes in the operations of the purchased machinery or equipment; provided that (1), with respect to third parties' technical processes which the Lessee has obtained the right to use by contract or agreement, the Lessor shall replace the Lessee as a party to the contract or agreement, and (2) with respect to technical processes owned, developed or controlled by the Lessee itself, the Lessor shall agree to pay the Lessee fair market value for use of the Lessee's technical processes

in said operations. Any contract or agreement into which the Lessee shall enter with a third party for the right to use technical processes belonging to that third party shall provide that the Lessor may become a party to that contract or agreement to the extent that those processes may be used for the protection of the Leased Lands. If the Lessee and the Lessor shall not agree as to the fair market value of the Lessee's technical processes, that value shall be determined as provided in section 32(a) for other property acquired by the Lessor upon termination of the lease.

Section 34. Lessee's Liability to the Lessor.

(a) The Lessee shall be liable to the United States for any damage suffered by the United States in any way arising from or connected with Lessee's activities and operations conducted pursuant to this lease, except where damage is caused by employees of the United States acting within the scope of their authority.

(b) The Lessee shall indemnify and hold harmless the United States from any and all claims arising from or connected with Lessee's activities and operations under this lease.

(c) In any case where liability without fault is imposed on the Lessee pursuant to this section, and the damages involved were caused by the action of a third party, the rules of subrogation shall apply in accordance with the law of the jurisdiction where the damage occurred.

Section 35. Appeals. The Lessee shall have the right of appeal (a) under 43 CFR 300.4 from any action or decision of any official of the Bureau, (b) under 30 CFR 231.74 from any action, order, or decision of any official of the Minerals Management Service, or (c) under applicable regulation from any action or decision of any other official of the Department, arising in connection with this lease, including any action or decision pursuant to section 23 of this lease with respect to the readjustment of terms and conditions.

Section 36. Interpretation of This Lease.

(a) The paragraph headings in this lease are for convenience only, and do not purport to, and shall not be deemed to, define, limit, or extend the scope or intent of the paragraph to which they pertain.

(b) As used in this lease, unless the context clearly indicates otherwise, a word in the masculine or neuter form shall be interpreted as equally applicable to the masculine, feminine, and neuter genders, and words in singular form shall be interpreted as equally applicable to singular and plural numbers.

(Appropriate signature lines)

OIL SHALE LEASE
ENVIRONMENTAL STIPULATIONS

Section 1. GENERAL

(A) Applicability of Stipulations. The terms, conditions, requirements and prohibitions imposed upon Lessee by these Stipulations are also imposed upon Lessee's agents, employees, contractors, and sub-contractors, and their employees. Failure or refusal of Lessee's agents, employees, contractors, subcontractors, or their employees to comply with these Stipulations shall be deemed to be the failure or refusal of the Lessee. Lessee shall require its agents, contractors, and subcontractors to include these Stipulations in all contracts and subcontracts which are entered into by any of them, together with a provision that the other contracting party, and its agents, employees, contractors, and subcontractors, and the employees of each of them, shall likewise be bound to comply with these stipulations.

(B) Changes in Condition. These Stipulations are based on existing knowledge and technology. They may be revised or amended by mutual consent of the Mining Supervisor, the Bureau District Manager, and the Lessee at any time to adjust to changed conditions or to correct an oversight. The Lessor may amend these stipulations at any time without the consent of the Lessee in order to make these stipulations consistent with any new Federal or State statutes for the protection of the environment upon their enactment and with regulations issued under those statutes. The Lessee, the Mining Supervisor, and the Bureau District Manager shall meet at least once a year to review advances in technology and, in a mutual endeavor, weight and decide the feasibility and need of revising or amending existing Stipulations.

The Lessor and the Lessee agree that, in this mutual endeavor to decide upon the feasibility and need for amending the existing Stipulations, they will act in good faith and in a sincere effort to make the Lessee's activities under the lease as free from environmental damage as is practicable. Toward this end, systems which require pollution control devices shall possess sufficient flexibility to adopt improved technology at practicable intervals and shall be constructed with the understanding that continued compliance with changing pollution control laws is required.

(C) Collection of Environmental Data and Monitoring Program.

(1) The Lessee shall develop and submit for approval of the Mining Supervisor a comprehensive environmental monitoring program as a part of the exploration plan, required by Section 10(d) of this lease.

The Lessee, following approval of the exploration plan, shall immediately implement the monitoring program which shall continue before, during, and subsequent to development operations. The environmental monitoring program shall be conducted until the Mining Supervisor has determined to his satisfaction that environmental conditions have been established after the termination of development operations which are consistent with the requirements of applicable Federal and State Statutes and regulations; however, the Mining Supervisor may terminate this requirement at an earlier date where it is in the public interest.

The purposes of the environmental monitoring program are: to determine environmental conditions existing prior to any development operations under the lease; to provide data for the design of an environmentally responsive detailed development plan required by section 10 of the lease; to provide a record during and subsequent to development of changes in the environment from conditions existing prior to development and from control sites where

appropriate; to provide a continuing check on compliance with provisions of the lease (including these attached stipulations), and all Federal, State and local environmental protection and pollution control requirements; to provide timely notice of detrimental effects and conditions and; to provide a factual basis for revision or amendment of these stipulations pursuant to Section 1 (B) hereof. In determining conditions existing prior to development, the Lessee may supplement site specific data with data compiled by others as approved by the Mining Supervisor. The source and substance of any such data shall be identified in the exploration plan required by Section 10(d) of the lease. Environmental data approved by the Mining Supervisor shall be collected for at least one full year and a report analyzing the year's data shall be submitted prior to submission of the detailed development plan. The environmental monitoring program shall be updated at the time of submission of the detailed development plan and may, at the discretion of, or with the approval of the Mining Supervisor, be modified at any time as necessary as a result of information obtained after approval of the environmental monitoring program.

The detailed development plan required by Section 10 of the lease, shall at the discretion of, or with approval of the Mining Supervisor, be modified at any time as necessary as a result of study of the monitoring data obtained after approval of the detailed development plan. Exploratory operations as approved by the Mining Supervisor, shall be permitted during the collection of environmental data.

(2) In conducting the environmental monitoring program, the Lessee shall adopt the following methods and shall obtain the information required below. The location and number of testing and sampling installations shall be determined by the Lessee unless otherwise directed by the Mining Supervisor. The environmental monitoring program shall include a quality assurance program approved by the Mining Supervisor which demonstrates sound experimental design consistent with the current state-of-the-art to assure high quality data collection. the Lessee shall initiate appropriate analytical and statistical determination of significant changes and trends. In the design and operation of the environmental monitoring program, the Lessee shall collect data for the duration of activities on the leased tract unless otherwise directed by the Mining Supervisor. Intra and interrelationships among biotic and abiotic parameters shall be determined, evaluated, and reported for direct and indirect impacts. The quality assurance program shall include, but not be limited to: quality control by standard reference materials, such as those available through established criticia of acceptablilty (e.g., EPA Air Quality Handbook and 10 CFR Part 50 Appendix D); method and frequency of calibration and maintenance, and testing programs to identify and quantify data validity and anomalies.

The Lessee shall maintain records of all information obtained under the environmental monitoring program and shall submit such records to the Mining Supervisor in a format and at intervals to be prescribed by him. Lessee shall promptly notify the Mining Supervisor of detrimental effects, conditions, and trends. In addition to the report analyzing the first year's environmental data, the Lessee shall submit quarterly progress reports during the collection of the first year's data. Not more than one year after obtaining approval of the detailed development plan and on each subsequent anniversary date the Lessee shall submit to the Mining Supervisor a report of the environmental monitoring programs as a part of the required annual progress reports on the development program. This portion of the annual report will be subject to

public review and comment. The reports required by this paragraph and other reports required by the Mining Supervisor shall be submitted in quantities to be determined by him.

(a) Surface Water. The Lessee shall construct gaging stations on the major drainages of the leased lands and, as required by the Mining Supervisor, upstream and downstream from the leased lands. Data collected at the stations shall include continuous streamflow records, continuous specific conductance records, continuous water temperature records, continuous precipitation records, continuous sediment records, and as directed by the Mining Supervisor, periodic analyses for selected inorganic and organic chemical constituents. Precipitation records shall include, data on short-term intensity of precipitation and on the chemical constituents in precipatation as approved by or as directed by the Mining Supervisor. The Lessee shall obtain data on the physical and chemical character of stream sediments at gaging stations and at other appropriate locations on streams that drain areas on and about the tract as directed by the Mining Supervisor. The Lessee shall compile an inventory of water features such as wells, springs and seeps on and about the lease tract. Such inventory shall include biotic and abiotic information, such as flow and physical and chemical properties or features, and utilization of such hydrologic features by flora and fauna.

(b) Ground Water. At each proposed or actual mine site, the Lessee shall drill a test well and shall, as directed by the Mining Supervisor, install one or more observation wells in each water-bearing zone defined by the test well. The Lessee shall collect samples of drill cuttings and shall make geophysical logs as directed by the Mining Supervisor. The Lessee shall isolate each water bearing zone penetrated by the test wells and shall conduct aquifer tests on each zone, as approved by or as directed by the Mining Supervisor. Aquifer testing shall be for the purpose of obtaining information about the water-bearing characteristics of each zone and about the effects of pumping on wells, springs, seeps, and streams in the area. The Lessee shall determine the water quality during aquifer tests by analyzing water samples for orgainic and inorganic chemical constituents, including, without limitations, trace constituents subject to drinking water standards and water pollution control regulations. The Mining Supervisor may require analysis of samples for such additional constituents as he may deem necessary. After the initial test, the lessee shall collect water samples from each well at intervals directed by the Mining Supervisor and analyze them for evidence of trends in water quality as determined by comparing the analyses with previous analyses.

The Lessee shall complete at least one observation well upgradient from each impoundment and raw or spent shale disposal site and at least two observation wells downgradient from these sites at depths and locations specified by the Mining Supervisor. The Mining Supervisor may require additional observation wells both on and off the lease tract to quantify effects on ground water hydrology and to provide adequate monitoring of the water quality of aquifers or water- bearing zones. The Lessee shall record water levels and temperatures in each observation well pursuant to a measurement schedule established by the Mining Supervisor. The Lessee shall determine the water quality of each observation well by analyzing samples for organic and inorganic constituents, including, without limitation, trace constituents subject to drinking water standards and water pollution controls. The Mining Supervisor may require analysis of samples on such a schedule and for such additional constituents he may deem necessary. After the initial

test of an observation well, the Lessee shall collect water samples from the well at intervals directed by the Mining Supervisor and analyze them for evidence of trends in water quality as determined by comparing the analyses with previous analyses.

(c) Air Quality and Meteorology. The Lessee shall submit for the Mining Supervisor's approval an Air Quality and Meteorology monitoring program designed to define the existing environment, define meteorology factors which might influence the transport and diffusion of pollutants which might be emitted by source on or near the tracts, identify the meteorology of the area for detailed planning purposes, monitor impacts of lease development and operation on air quality, determine source and magnitude of plant emissions, and provide information for plant operation to minimize impacts of operations.

In the collection of data to meet the above stated objectives, the Lessee shall record air quality, using strategically-located stations. The number and location of stations shall be recommended by the Lessee and approved by the Mining Supervisor. Once established pursuant to this stipulation the number and location of such stations shall not be changed except by mutual consent of the Mining Supervisor and Lessee.

The Lessee shall collect air quality data for all pollutants that the Mining Supervisor determines are necessary, based on the Lessees' submittal of a detailed description of emissions anticipated during development, including but not limited to sulphur dioxide, hydrogen sulphide, suspended particulates, hydrocarbons, oxides of nitrogen, ozone, and carbon monoxide.

In addition, the Lessee shall establish a meteorological station in reasonable proximity to each proposed plant site to record, at a minimum, wind direction and speed (vane and anemometer) at two levels, one at least 30 meters above the surface of the plant site, one at approximately 10 meters above the surface of the plant site, and temperature at two levels, one at least 30 meters above the surface of the plant site, and one at approximately 10 meters above the surface of the plant site, and humidity at the lower level. An upper air data collection program shall be implemented as deemed necessary by the Mining Supervisor for the purpose of obtaining information for diffusion modeling.

(d) Flora and Fauna. The Lessee shall conduct studies of the flora and fauna of the leased lands and of all other lands lying within a mile of the leased lands, and of all lands to be used for disposal of residues from mining and processing oil shale and associated minerals, and also of the aquatic habitat as far downstream as the Mining Supervisor shall require. The selection of sampling periods for these studies will be based on the latest available scientific information, and must be approved by the Mining Supervisor. Flora studies will determine species composition, condition, density, cover, productivity, and utilization by terrestrial fauna and by vegetation type and, where applicable, aquatic fauna. Fauna studies will determine species, population indices and/or density, behavior parameters, daily and seasonal movement patterns, and habitat utilization and preference for terrestrial fauna and, where applicable, aquatic fauna.

(e) Soil Survey and Productivity Assessment. The Lessee shall conduct an intensive soil survey and productivity assessment of all portions of the leased lands not previously mapped by the Soil Conservation Service with a Class I survey. This survey must include the preparation of maps, tables, and reports describing soil types and series,depth of the various layers of soil horizons, but not more than a depth of 50 feet from the

surface, strike and dip of the material, slopes, solar exposure, vegetative cover, erodability, and other physiographic freatures as required by the Mining Supervisor. The Soil Conservation Service standard procedures shall be used in meeting the requirements of this stipulation. A soil chemistry program, approved by the Mining Supervisor, is required for all areas to be directly affected by on-tract operations.

(3) The environmental monitoring program shall be an integral part of the detailed development plan required in Section 10 of the lease, and at the time of the submission of the plan the Lessee shall provide the Mining Supervisor with a complete compilation of the baseline data collected above and the record of the monitoring program for any period subsequent to the conclusion of that compilation.

(4) Not more than one year after obtaining approval of the detailed mining plan and on each subsequent anniversary date the Lessee shall submit to the Mining Supervisor a report of the baseline data collected and a report of the monitoring programs as a part of the required annual progress reports on the development program. This portion of the annual report will be subject to public review and comment.

(D) Emergency Decisions. Any decisions or approvals of the Mining Supervisor required by these Stipulations to be in writing may in emergencies be issued orally, with written confirmation as soon thereafter as possible.

(E) Environmental Briefing. During the life of this Lease, Lessee shall provide that such Federal and State employees as may be designated by the Mining Supervisor shall be briefed on environmental and other pertinent matters. The Lessee shall provide for such briefings upon the request of the Mining Supervisor, but the Mining Supervisor shall request only such briefings as may be reasonably necessary to effectuate the provisions of this Lease. Lessee shall make arrangements for the time, place, and attendance at such briefings. Lessee shall bear all costs of such briefings other than salary, per diem, subsistence and travel costs of Federal and State employees.

(F) Construction Standards. The general design of all buildings and structures shall comply with the latest edition of the Uniform Building Code (U.B.C.). Structural steel shall be designed in accordance with the latest edition of the American Institute of Steel Construction "Specifications for Design, Fabrication and Erection of Structural Steel for Buildings." Reinforced concrete shall comply with the latest edition of the American Concrete Institute's Building Code Requirements for Reinforced Concrete." Engineering works for impoundments shall conform to standard engineering practice sufficient to withstand the 100-year flood in the drainage in which installed. All impoundments shall be constructed to minimize leakage, unless otherwise authorized by the Mining Supervisor.

(G) Housing and Welfare of Employees. The Lessee, in the exercise of his right under section 2 of the Lease to construct buildings and other facilities for the housing and welfare of his employees, shall at all times make certain that these facilities are situated, constructed, operated, and maintained in an orderly manner, satisfactory to the Mining Supervisor. While no general restriction is imposed upon the construction of facilities necessary to the employees' health and well-being, such construction shall be subject to the Mining Supervisor's approval and shall not unreasonably damage the environment of the leased lands.

(H) Firearms. The carrying of firearms by employees while on the job or in company owned vehicles, with exception of security guards, shall be prohibited.

(I) Posting of Stipulations and Plans. The Lessee shall ensure that copies of these Stipulations and any approved exploration and development plans are available at the operating sites and for inspection by all on-the-ground operating personnel. Notice prohibiting carrying of firearms onto the tract by employees shall be prominently displayed at all entrances to the tract.

(J) Employee Transportation. The lessee shall use mass transit of employees wherever possible to reduce chance of accidents, traffic congestion, and road kill of wildlife.

Section 2. ACCESS AND SERVICE PLANS

(A) Transportation Corridor Plans. The Lessee shall provide corridor plans for roads, pipelines and utilities on the Leased Lands for approval by the Mining Supervisor. Each plan shall include probable major design features and plans for the protection of the environment, control of pollution, minimization of erosion, rehabilitation and revegetation of all disturbed areas not required in operation of the transportation system, both during and after construction. The Lessee shall, to the maximum extent practicable, make use of multi-use corridors for roads, pipelines and utilities.

(B) Regulation of Public Access. After road construction is completed, the Lessee shall, upon consultation with the Lessor, permit reasonable, free and unrestricted public access to and upon the road and rights-of-way for all lawful and proper purposes except in plant sites, mine sites, disposal areas, and other operational areas which may be closed to the general public. The Lessee shall regulate public access and public vehicular traffic as required to facilitate operations and to protect the public and, to the extent reasonable, livestock and wildlife from hazards associated with construction. For this purpose the Lessee shall provide warnings, flagmen, barricades, and other safety measures as necessary. Whenever the Mining Supervisor shall determine that the Lessee's regulation of access and traffic is unreasonable, or that the Leseee's provision of safety measures is inadequate, he shall so inform the Lessee who shall immediately take corrective measures.

(C) Existing and Planned Roads and Trails. Where feasible, the Lessee shall use existing roads and trails. Unless the Mining Supervisor shall direct otherwise, roads and trails shall be located, constructed, maintained, and closed according to the specifications of the Bureau of Land Management and shall include drainage structures where needed.

(D) Waterbars and Breaks. The Lessee shall divert runoff from roads and uphill slopes by means of waterbars, waterbreaks, or culverts constructed in accordance with Bureau specifications.

(E) Pipeline Construction Standards. In the design and construction of oil pipelines and the choice of materials for them, the Lessee shall follow the standards (wherever they may be made applicable) established by the Department of Transportation and, if these standards should ever be revised, supplemented, or superseded, shall follow the new standards in new construction. These standards include:

(1) 49 CFR 192, Transportation of Natural and Other gas by pipeline; and

(2) 49 CFR 195, Transmission of Liquids by pipeline.

(F) Pipeline Safety Standards. The Lessee shall meet, where applicable, the safety standards and reporting requirements set forth in the following, as now in effect and as hereafter amended, or, if these regulations should be superseded, the regulations or other rules superseding them:

(1) 49 CFR, Part 190, Interim Minimum Federal Safety Standards;
(2) 49 CFR, Part 191, Report of Leaks;
(3) 49 CFR, Part 192, Transportation of Natural and Other Gas and Water;
(4) 49 CFR, Part 195, Transmission of Liquids by pipeline;

(G) Shut-Off Valves. The Lessee shall ensure that oil transportation pipeline designs provide for automatic shut-off valves at each pumping or compressor station and such additional valves as may be necessary in view of:

(1) Terrain and drainage systems traversed,
(2) Population centers,
(3) Wildlife and fishery habitat,
(4) Public water supplies and significant water bodies,
(5) Hazardous geologic areas, and
(6) Scenic Values.

The Lessee shall install any additional valves required by the Mining Supervisor.

(H) Pipeline Corrosion. With regard to oil transportation pipelines, the Lessee shall submit detailed plans to the Mining Supervisor for corrosion-resistant design and methods for early detection of pipeline corrosion. These shall include:

(1) Pipe material and welding techniques to be used and information on their particular suitability for the environment involved;

(2) Details on the external pipe protection to be provided (coating, wrapping, etc.), including information on variation of the coating process to cope with variations in environmental factors;

(3) Plans for cathodic protection including details of impressed ground sources and controls to ensure continuous maintenance of adequate protection over the entire surface of the pipe;

(4) Details of plans for monitoring cathodic protection current including spacing of current monitors; and

(5) Provision of periodic surveys of trouble spots, regular preventive maintenance surveys, regular surveys for external and internal deterioration which may result in failure, and special provisions for abnormal potential patterns resulting from crossings with other pipelines or cables.

(I) Electric Transmission Facilities. The Lessee shall design and construct telegraph, telephone, electric powerlines, distribution lines and other transmission facilities in accordance with the guidelines set forth in "environmental criteria for electric transmission system" (U.S.D.I., U.S.D.A., 1970), as now or in the future amended, or if these guidelines should be superseded, in the guidelines or other rules superseding them. Distribution lines shall be designed and constructed in accordance with REA Bulletin 61-10 (Powerline contracts by Eagles and other Large Birds), as now or in the future amended, or, if these guidelines should be superseded, in the guidelines or other rules superseding them.

(J) Natural Barriers. Where a road or exploratory site cuts a natural barrier used for livestock control, the Lessee shall, at his own expense, close the opening by the use of a fence or other suitable barrier meeting Bureau Standards.

(K) Specifications for Fences, and Cattleguards. Fences and cattleguards constructed by the Lessee shall meet established Bureau specifications and standards.

(L) Crossings. The Lessee shall take all steps necessary to make certain that roads constructed under this lease do not prevent or unreasonably

disrupt the use of existing roads, foot trails, pipelines, and other right-of-way or major animal migration routes. This requirement shall include the construction of suitable overhead or underground crossings where they are determined to be necessary by the Mining Supervisor.

(M) Alternate Routes. If during construction the Lessee's activities shall interfere with the free use of existing roads and trails used by persons, whether or nor recorded, he shall provide such alternate roads and trails as the Mining Supervisor may determine to be needed.

(N) Off-Road Vehicle Use. The Lessee shall use off-road vehicles in a manner consistent with applicable regulations.

Section 3. FIRE PREVENTION AND CONTROL

(A) Instructions of the Mining Supervisor.

(1) The Lessee shall comply with the instructions and directions of the Mining Supervisor concerning the use, prevention and supression of fires, and shall make every reasonable effort to prevent, control and suppress any fire on land subject to the lease. Uncontrolled fires must be immediately reported to the Mining Supervisor.

(2) (a) The Lessee shall construct fire lines or perform clearing when determined by the Mining Supervisor to be necessary for forest, brush and grass fire prevention.

(b) The Lessee shall comply with the National Fire Codes on handling, transportation, storage, use and disposal of flammable liquids, gases, and solids.

(c) The Lessee shall take all appropriate actions to prevent oil shale outcrop fires.

(B) Liability of Lessee. The control and suppression of any fires on the leased lands (or on adjoining public lands which have spread from the leased lands) caused by the Lessee or his employees, contractors, sub-contractors, or agents shall be at the expense of the Lessee. Upon the failure of the Lessee to control and suppress such fires in a manner satisfactory to him, the Mining Supervisor shall take such steps as are necessary to control and suppress the fire, either alone or in conjunction with other Federal, State, and local authorities, and the cost of such control and suppression shall be borne by the Lessee.

Section 4. HABITAT MANAGEMENT

(A) Exploration Period. The Lessee will submit, as part of the exploration plan, a vegetation plan for all areas to be disturbed during the exploration period. Prior to any disturbance, the Mining Supervisor will approve any necessary mitigation measures.

(B) Development Period. The Lessee shall submit for approval by the Mining Supervisor, as a part of the detailed development plan, a habitat management plan which shall include the steps which the Lessee shall take to:

(1) Avoid or, where avoidance is impracticable, minimize damage to fish and wildlife habitat, including water supplies;

(2) Restore such habitat in the event it is unavoidably destroyed or damaged;

(3) Provide alternate habitats; and

(4) Provide controlled access to the public for the enjoyment of the wildlife resources on such lands as may be mutually agreed upon. The plan shall include, but not be limited to, detailed information on activities, time schedule, performance standards, proposed accomplishments, and ways and means of avoiding or minimizing environmental impacts of fish and wildlife.

(C) Mitigation of Damage. Wherever destruction or significant disturbance of fish and wildlife habitat, not foreseen in the detailed development plan, will or does occur, the Lessee shall submit, for the Mining Supervisor's approval at least 60 days prior to the destruction or damage of the habitat, those measures which the Lessee proposes to take to comply with the requirement of 30 CFR 231.4(b), as now in effect or as hereafter amended or, if that regulation should be superseded, the regulation of other rules superseding it, to avoid, or where avoidance is impracticable, minimize and repair, injury or destruction of fish and wildlife and their habitat. As a general rule, the proposed measures should provide for habitat of similar type and equal in quantity and quality to that destroyed or damaged. The Mining Supervisor shall, within 60 days after the submission of the proposed measures to him, either approve or disapprove them. If he shall approve them, the Lessee shall execute the proposed measures for the mitigation of the destruction or damage of the habitat. If the Mining Supervisor shall disapprove the measures, he shall offer the Lessee an opportunity for consultation at which, whenever possible, he shall inform the Lessee of any changes which will make the measures acceptable.

(D) Big Game. The Lessee shall construct big game drift fences when and where necessary to direct big game movement around or away from oil shale development areas.

(E) Posting of Notices. The Lessee shall post in reasonable and conspicuous places notices informing its employees, agents, contractors, subcontractors, and their employees of all applicable laws and regulations governing hunting, fishing, and trapping.

Section 5. HEALTH AND SAFETY

(A) In General. The Lessee shall take all measures necessary to protect the Health and Safety of all persons affected by its activities and operations and shall immediately abate any activity or condition which threatens the life of any person or which threatens any person with bodily harm.

(B) Compliance with Federal Health and Safety Laws and Regulations. The Lessee shall comply with the Federal Metal and Non-metallic Mine Safety Act of 1966 (30 U.S.C. 721-740), as now in effect or as hereafter amended, or if it should be superseded, with the statute superseding it, and the Occupational Health and Safety Act of 1970 (29 U.S.C. 651-678), as now in effect, or as hereafter amended, or, if it should be superseded, with the statute superseding it, and all health and safety standards promulgated pursuant thereto.

(C) Use of Explosives. The Lessee shall ensure that all blasting operations, including the purchase, handling, transportation, storage, use, and destruction of blasting agents are performed in conformance with Public Law 91-452, October 15, 1970 (18 U.S.C. 88841-848), as now in effect or as hereafter amended, or if it should be superseded, with the statute superseding it, and the regulations promulgated thereunder which are now in 26 CFR 181.

Section 6. HISTORIC AND SCIENTIFIC VALUES

(A) Cultural Resources.

(1) Before undertaking any activities that may disturb the surface of the leased lands, the lessee shall conduct a cultural resource field inventory in a manner specified by the Mining Supervisor on portions of the area that may be adversely affected by lease-related activities and which were not previously inventoried. The inventory shall be conducted by a qualified

professional cultural resource specialist (i.e. archaeologist, historian, or historical architect, as appropriate), approved by the Mining Supervisor. A report of the inventory and recommendations for protecting any cultural resources identified shall be submitted to the Mining Supervisor. The Lessee shall undertake measures, in accordance with instructions, from the Mining Supervisor, to protect cultural resources on the leased lands. The lessee shall not commence the surface disturbing activities until permission to proceed is given by the Mining Supervisor.

(2) The lessee shall protect all known cultural resource properties within the lease area from lease-related activities until the cultural resource mitigation measures can be implemented as part of the detailed development plan.

(3) The cost of conducting the preparing reports, and carrying out inventory preparing reports, and carrying out mitigation measures shall be borne by the lessee.

(4) If cultural resources are discovered during operations under this lease, the lessee shall immediately bring them to the attention of the Mining Supervisor. The lessee shall not disturb such resources, except as may be subsequently authorized by the Mining Supervisor. As soon as practicable, the Mining Supervisor will evaluate or have evaluated any cultural resources discovered and will determine if any action may be required to protect or preserve such discoveries. The cost of data recovery for cultural resources discovered during lease operations.

(B) <u>Paleontological Resources</u>.

(1) Before undertaking any activities that may disturb the surface of the leased lands, the Lessee shall contact the Mining Supervisor to determine whether the lessee will be required to conduct a paleontological appraisal of the mine plan and adjacent areas, or exploration plan areas, that may be adversely affected by lease-related activities. If it is determined that one is necessary, the paleontological appraisal shall be conducted by a qualified paleontologist approved by the Mining Supervisor using published literature and, where appropriate, the field appraisals for determining the possible existence of fossils of scientific significance. A report of the appraisal and recommendations for protecting any fossils of significant scientific interest on the leased lands so identified shall be submitted to the Mining Supervisor. When necessary to protect and collect the fossils of significant scientific interest on the leased lands, the lessee shall undertake the measures provided in the approval of the mining and reclamation plan or exploration plan.

(2) The lessee shall not knowingly disturb, alter, destroy or take any fossils of significant scientific interest, and shall protect all such fossils in conformance with the measures included in the approval of the detailed development plan or exploration plan.

(3) The Lessee shall immediately bring any such fossils that might be altered or destroyed by his operations to the attention of the Mining Supervisor. Operations may continue as long as the fossil specimen or specimens would not be seriously damaged or destroyed by the activity. The Mining Supervisor shall evaluate or have evaluated such discoveries brought to his attention as soon as possible and shall notify the lessee as to what action shall be taken with respect to such discoveries.

(4) All such fossils of significant scientific interest shall remain under the jurisdiction of the United States. Copies of all paleontological resource data generated as a result of the lease term requirements will be provided to the Mining Supervisor.

(5) The cost of any required salvage of such fossils shall be borne by the Lessee.

(6) These conditions apply to all such fossils of significant scientific interest discovered within the lease area whether discovered in the overburden, interburden, or any mining zone.

Section 7. OIL AND HAZARDOUS MATERIALS

(A) Spill Contingency Plans. The Lessee agrees to submit spill contingency plans to the Mining Supervisor with the detailed development plan. This plan shall provide for the control of spills of oil or other hazardous substances which for purposes of this section 7 shall be defined in section 311(a)(14) of the Federal Water Pollution Control Act, as amended (86 Stat. 816, 863), as now in effect of as hereafter amended, or if it should be superseded, the statute superseding it.

The plans shall conform to this stipulation and the National Oil and Hazardous Substances Pollution Contingency Plan, 36 FR 16215, August 20, 1971, as now in force or as hereafter amended, or, if it shall be superseded, the document superseding it, and shall: (1) include a description of positive spill prevention efforts which the Lessee shall make; (2) include provisions for spill control; (3) provide for immediate corrective action including spill control and restoration of the affected resource; (4) provide that the Mining Supervisor shall approve any material or devices used for spill control and shall approve any disposal sites or techniques selected to handle spilled matter; and (5) include separate and specific techniques and schedules for cleaning of spills on land, rivers, and streams. As used in this stipulation, spill control is defined as including detection, location, confinement, and cleanup of the spill.

(B) Responsibility. If, during mining operations, any oil or other hazardous substance should be discharged, the control, removal, disposal, and cleanup of that substance, wherever found, shall be the responsibility of lessee. Upon the failure of the lessee to control, remove, dispose of, or clean up the discharge, or to repair all damages resulting therefrom, the Mining Supervisor may take such measures as he deems necessary to control, remove, dispose of, or clean up the discharge and restore the area, including, where appropriate, the aquatic environment and fish and wildlife habitats, at the full expense of the lessee. Such action by the Mining Supervisor shall not relieve lessee of any responsibility as provided in this lease.

(C) Reporting of Spills and Discharges. The lessee shall give immediate notice of any spills or discharges of oil or other hazardous substances to: (1) the Mining Supervisor and (2) such other federal and state officials as are required by law to be given such notice. Any oral notice shall be confirmed by the lessee in writing as soon as possible.

(D) Storage and Handling. The lessee shall store oil, petroleum products, industrial chemicals and similar toxic or volatile materials in durable containers and locate such materials so that any accidental spillage will not drain into water courses, lakes, reservoirs, or groundwater. Unless otherwise approved by the Mining Supervisor, the lessee shall store substantial quantities (more than 500 gallons) of such materials in an area surrounded by impermeable containment structures. The volume of the containment structures shall be at least: (1) one-hundred ten (110) percent of the largest tank plus displacement of all other tanks in the compound below the dike height or liquid level; plus (2) a volume sufficient for maximum trapped precipitation and run-off which might be impounded at the time of a spill. The earthen dike must have a flat surface three feet wide on top of the dike.

(E) Pesticides and Herbicides. The Lessee shall not use pesticides and herbicides without the approval of the Mining Supervisor. Pesticides and herbicides shall be considered treatments of last resort, to be used only when reasonable alternatives are not available and where their use is consistent with protection and enhancement of the environment. Where pesticides and herbicides are used, they shall be used only with the approval of the Mining Supervisor and the type, amount, method of application, storage, and disposal shall be in accordance with applicable federal and state procedures.

Section 8. POLLUTION--AIR

(A) Air Quality. The lessee shall utilize and operate all facilities and devices in such a way as to avoid, or, where avoidance is impracticable, minimize air pollution. At all times during construction and operation, lessee shall conduct its activities in accordance with all applicable air quality standards and related plans of implementation adopted pursuant to the Clean Air Act, as amended (40 U.S.C. (1857-1857-1), as now in effect or as hereafter amended, or if it should be superseded, the statute superseding it, and applicable state standards. Further, the Lessee shall submit an air quality control program for approval of the Mining Supervisor as part of the detailed development plan. The program shall include descriptions of emission sources and concentrations, treatment facilities and operations, and the results of emission modeling.

(B) Dust. The Lessee shall make every reasonable effort to avoid, or, where avoidance is impracticable, minimize dust problems. Where necessary, sprinkling, oiling, or other means of dust control shall be required on roads and trails. The lessee shall conduct processing operations so as not to create environmental or health problems associated with dust.

(C) Burning. The Lessee shall not burn waste, timber, or debris, except when disposal is essential and other methods of disposal would be more harmful to the environment and when authorized by the Mining Supervisor.

Section 9. POLLUTION--WATER

(A) Water Quality. The Lessee shall utilize and operate all facilities and devices in such a way as to avoid or, where avoidance is impracticable, minimize water pollution. At all times during construction and operation, lessee shall conduct its activities in accordance with all applicable Federal and State water standards and related plans of implementation, as then in force. Where applicable federal and state standards do not exist, the Mining Supervisor may establish reasonable standards to prevent degradation of water, and the lessee shall comply with those standards. The lessee shall not discharge waste water into any aquifer deemed by the Mining Supervisor to be a potentially valuable water supply nor into any aquifer which will discharge the waste into a surface stream.

(B) Disturbance of Existing Waters. All construction activities, exclusive of actual mining activities, that may cause the creation of new lakes, drainages of existing ponds, diversion of natural drainages, alteration of stream hydraulics, disturbance of areas of stream beds or degradation of land and water quality or adversely affect the environmental integrity of the area prohibited unless approved in writing by the Mining Supervisor.

(C) Control of Waste Waters. In areas where overburden, water, or waste from mines or processing plants might contain toxic or saline materials, the Lessee shall:

(1) Divert surface or ground water so as to avoid the formation of toxic and saline water and its drainage into streams, or, where avoidance is impracticable, to minimize the formation of such waters and drainage, by preventing the entry or reducing the flow of water into the workings, waste piles, or overburden-storage areas;

(2) Dispose of refuse and spent shale from mining and processing in a manner which will avoid the discharge of toxic drainage or saline water into surface or ground water;

(3) Employ, upon termination of operations or use of any mine, processing plant, or waste disposal site, all practicable closing measures consistent with ecological principles and safety requirements in order to avoid the formation and discharge of toxic or saline water;

(4) Dispose of toxic and saline water derived from mining, processing, or refining operations in a manner that does not pollute surface or ground waters;

(5) During mining operations, monitor spoil and refuse for the presence of materials likely to yield unacceptable alkaline, acidic, saline, or toxic solutes; and

(6) Reinject no water, except in compliance with Federal and State standards then in effect and where authorized to do so by the Mining Supervisor; if the Lessee does reinject water, he shall establish such monitoring as the Mining Supervisor shall require.

(D) Cuts and Fills. The Lessee shall not cut or fill near or in streams which will result in siltation or accumulation of debris unless approved in writing by the Mining Supervisor.

(E) Crossings. The location of crossings of perennial streams, lakes, and rivers must be approved in writing by the Mining Supervisor. To control erosion, the Lessee shall maintain buffer strips at least 200 feet wide on each side of a stream in their natural and undisturbed state unless otherwise authorized in writing by the Mining Supervisor.

(F) Road Surfacing Materials. All road surfacing materials used by the Lessee must be approved by the Mining Supervisor.

(G) Water Management Plan. The Lessee shall submit a water management program for approval of the Mining Supervisor as part of the detailed development plan. The program shall include hydrologic monitoring during all phases of development, operations, and abandonment, and shall address descriptions of water handling facilities, surface flow diversion and augmentation, dams, impoundments, seepage control, treatment facilities, and ground water control in the vicinity of mine workings, in-situ retorts and surface waste disposal areas. A contingency plan shall be included for excess surface and ground water flow. Impoundments for storage and treament of poor quality water shall be constructed to prevent contamination of ground or surface water. The plan shall include best available information on the source, storage, and disposal of all water, and related estimates of water quantity and quality.

Section 10. POLLUTION--NOISE

The Lessee shall comply with all applicable Federal and State standards on noise pollution, as now in effect or as hereafter amended, or, if they should be superseded, the standards superseding them. In the absence of specific noise pollution standards, the Lessee shall keep noise at or below levels safe and acceptable for humans, as determined by the Mining Supervisor.

Section 11. REHABILITATION

(A) In General. The Lessee shall, in accordance with approved plans, rehabilitate all affected lands to a usable and productive condition consistent with or equal to pre-existing land uses in the area and compatible with existing, adjacent undisturbed natural areas, or in accord with future planned use as determined by the surface managing agency at the time the detailed development plan is prepared by the lessee. Rehabilitation methods include, but are not limited to the following: leveling, backfilling, compaction, covering the surface with topsoil, and revegetating the spoil banks and pit areas consistent with sound restoration methods. The Lessee shall leave reclaimed land in a usable, non-hazardous condition such that soil erosion and water pollution are avoided or minimized. The Lessee shall, to the extent practicable, conduct such backfilling, compaction, leveling, and grading concurrently with the mining operations. Upon removal of property at termination of the lease pursuant to sections 31 and 32 of the lease, the Lessee shall, in accordance with approved plans, complete the restoration of affected lands to a usable and productive condition at least equal to pre-existing land uses in the area and compatible with existing adjacent undisturbed natural areas or to a condition determined by the surface managing agency.

(B) Management Plan. The Lessee shall submit for approval by the Mining Supervisor an erosion control and surface rehabilitation plan as part of any exploration or development plan. The initial plan shall be submitted not less than 60 days prior to start of mining site preparation and updated each year thereafter before March 15. The plan shall include, but not be limited to, detailed information on activities, areas, time schedules, standards, accomplishments, methods of eliminating or minimizing oil shale development impacts, and preserving existing topsoil-like material. The Lessee shall base erosion control plans and procedures on a maximum 100-year precipitation rate characteristic of the area. If a 100-year rate is not available the Lessee shall use data based on the longest period of reliable information. Procedures and plans shall consider flash flood effects, mud flows, mudslides, landslides, rock falls, and other similar types of material mass movement.

(C) Stablization of Disturbed Areas. The Lessee shall leave all disturbed areas in a stabilized condition. Stabilization practices shall include, as determined by the needs of specific sites: seeding; planting; mulching; and the placement of mat binders, soil binders, rock and gravel blankets or other such structures. Seeding and planting shall be repeated as often as the Mining Supervisor shall deem reasonable, if prior attempts to revegetate are unsuccessful. All trees, snags, stumps or other vegetative material, not having commercial, ecological, wildlife, or construction value, shall be considered for mechanical chipping and spreading in a manner that will aid seeding establishment and soil stabilization or handled in a manner approved by the Mining Supervisor.

(D) Surface Disturbance On-Site. The Lessee shall correct surface disturbance which may induce soil movement or water pollution, or both, whether during or after construction or mining, in accordance with the surface rehabilitation plan. Wherever possible, slopes shall be maintained or constructed at as low an angle as possible to facilitate revegetation.

(E) Areas of Unstable Soils. The Lessee shall, where possible, avoid areas having soils that are susceptible to slides and slips, excessive settlement, severe erosion and soil creep during construction or operation. When such areas can not be avoided the Lessee shall design construction to ensure maximum stability. The Lessee shall make soil foundation investigations in conjunction with construction activities. The Lessee shall make such data available to the Mining Supervisor upon request.

(F) Materials. The Lessee shall, when feasible, utilize waste rock from the mining operations for road beds, fills and other similar construction purposes. When not feasible, gravel and other construction materials shall be purchased in accordance with 43 CFR 3610, as now in effect or as here after amended, or, if it shall be superseded, the regulation or rule superseding it, except that the sale of such materials from stream beds and upland soil areas shall be avoided unless otherwise approved by the Bureau District Manager.

(G) Slopes of Cut and Fill Areas. To the extent consistent with good mining practice, the Lessee shall maintain all cut and fill slopes in a stable condition for the duration of the lease.

(H) Impoundments. The Lessee shall establish safe access to permanent water impoundments for persons, livestock, and wildlife, but, where consumption of such water would be harmful to humans or to use of such water would be detrimental to animals, he shall take necessary steps to prevent access by those to whom it would be harmful or detrimental.

(I) Flood Plains. The Lessee shall not construct improvements or conduct operations in flood plains or stream drainages when it is reasonable to expect risk to human life, pollution damage, or destruction of the existing environment caused by flood damage, without the express permission of the Mining Supervisor and without providing for protection of any such improvement constructed.

(J) Land Reclamation. The Lessee shall, unless otherwise directed by the Mining Supervisor, backfill, compact, level, final grade, cover with topsoil or topsoil-like material and initiate revegetation of each segment of the operation area in accordance with the rehabilitation plan as soon as that segment is no longer needed, but not later than one year after completion of the particular operation, unless an alternative schedule has been approved by the Mining Supervisor. Slopes to be revegetated shall be constructed at as low an angle as possible. Special attention shall be given to minimize deleterious hydrologic effects.

(K) Overburden. The Lessee shall, unless otherwise directed by the Mining Supervisor, separate overburden material and stockpile it separately as to topsoil, and rock material for later use as fill and as top dressing for rehabilitation of disturbed areas.

(L) Revegetation.

(1) The Lessee shall revegetate all portions of the leased lands which have been disturbed by his operations as soon as possible after the disturbance has ended in order to prevent, or, if prevention is impracticable, to minimize erosion and related problems. The Lessee shall restore the vegetation of disturbed areas by reestablishing permanent vegetation of a quality which will support fauna of the same kinds and in the same numbers as those existing at the time the environmental data was obtained under section 1 (C) of these stipulations. Plans for revegetation, including species, density, and timing, must be submitted to the Mining Supervisor for approval. The Mining Supervisor may require any reasonable methods of revegetation, and, if he deems it desirable, may require the Lessee to fence areas to assist revegetation. However, if the Lessor determines, at the time of submission of the detailed development plan under section 10(A) of this lease, that the leased lands will, upon the termination of the lease, be put to a different use from that to which they were devoted immediately prior to the issuance of this lease, the Mining Supervisor may require the Lessee to revegetate the land to meet that objective, except that the Lessee shall not be required to expend more money than that needed to meet the first revegetation standard.

(2) The Lessee shall initiate a revegetation program approved by the Mining Supervisor (with concurrence of BLM) at the start of production to (1) delineate those parameters necessary to establish vegetation at a specific location and show that successful changes in vegetation are compatible with the requirements under subparagraph (1) above.

(3) The Lessee shall demonstrate at the time of submission of the detailed development plan under section 10(a) of this lease that revegetation technology is available to enable him to provide the revegetation of the disturbed areas which is required under paragraph (1) of this subsection. If, in the opinion of the Mining Supervisor, the Lessee has failed to demonstrate the required technology, he shall be required to submit for approval a program designed to obtain the required technology. If the program to obtain the necessary technology is satisfactory, the Mining Supervisor may approve the Lessee's development plan submitted under section 10(a), but, if the Lessee has not demonstrated the necessary technology by the tenth Anniversary Date after the Lease Year in which the development plan under section 10(a) was approved, the Lessee shall cease all exploratory, development, and production operations under that plan until he has demonstrated that the necessary technology is available to him. The Lessee shall report annually to the Mining Supervisor on the progress of this approved program to obtain the required technology. If the progress appears inadequate at any time, the Mining Supervisor may request the Lessee to amend the program. Whenever the Lessee has demonstrated the necessary technology, the required program shall terminate. Where the Mining Supervisor finds the Lessee has conducted his program to obtain technology, including any requested amendments, in a diligent manner and has expended funds in excess of $500,000 of that program, the Secretary may determine the expenditures in excess of that figure to be extraordinary costs within the terms of section 7(D) of the lease and may credit those excess expenditures against any present or future royalties due the Lessor, provided the results of the program are made public.

Section 12. SCENIC VALUES

(A) Scenic Considerations in General. The Lessee shall, except where the Mining Supervisor has approved otherwise, use the following standards in all designing, clearing, earthmoving, and construction:

(1) Contours compatible with the natural environment shall be used to avoid straight lines.

(2) Natural colors consistent with the local environment such as pastels or muted shades of brown, green, reds, or greys shall be used in painting of facilities installed on the lease. Bright or unnatural colors shall be avoided except for use in warning signs or signals.

(3) Small natural openings or the edges of larger openings in the natural environment shall be utilized in construction of facilities, or disturbing the land surface.

(4) During the time when the land is disturbed, the portion of land which is not under revegetation programs shall only be those areas required under the mining plan for mining, storage, processing, or disposal operations and related facilities.

(5) Contouring of the disturbed area for reclamation shall simulate natural opening or areas consistent with the surrounding topography.

(B) Consideration of Aesthetic Values. The Lessee shall consider existing aesthetic values in all planning, construction, reclamation and mining operations. All operations, including, but not limited to, design and

construction of roads, pipelines and transmission lines, shall, where practicable, be performed so as to minimize visual impact, make use of the natural topography, and to achieve harmony with the landscape.

(C) Protection of Landscape. The Lessee shall design any structures and facilities built under this lease so that they will, to the extent practicable, blend with the natural landscape.

(D) Signs. The Lessee shall design and construct signs that are rustic in appearance and to conform to BLM sign standards.

Section 13. VEGETATION

(A) In General.

(1) The Lessee shall reserve from cutting and removal all timber and other vegetative material outside the clearing boundaries and all blazed, painted or posted trees which are on or mark the clearing boundaries, with the exception of dangerous trees or snags designated as such by the Mining Supervisor.

(2) The Lessee shall ensure that all trees, snags or other woody material cut in connection with clearing operations are felled into the right-of-way and away from live water courses.

(B) Timber. The Lessee shall deal with timber in accordance with the following: clearing and grubbing limits shall be approximately 5 ft. outside of the edge of any cut or fill; where practicable, trees, snags, stumps or other woody material not having wildlife value or value to the Lessee shall be mechanically chipped and spread in a manner that will aid seeding establishment and soil stabilization or handled in a manner approved by the Mining Supervisor; clearing boundaries shall be identified on the ground prior to clearing operations.

(C) Clearing and Stripping. The Lessee may clear and strip only such land as is necessary for mining, processing, disposal, and other operations under the lease. In connection with such operations the Lessee may clear and strip land necessary for roadbeds, but such roadbed widths shall be not more than 25 feet from the centerline, unless specified by the Mining Supervisor.

Section 14. WASTE DISPOSAL

(A) Mine Waste. The Lessee shall, in accordance with the detailed development plan under section 10(a) of this lease, backfill or reclaim excavated material and spent shale and shall compact it thoroughly by machinery to avoid or, where avoidance is impossible, minimize erosion. The Lessee shall design slope faces of waste piles to ensure slope stability and shall revegetate slope faces in accordance with the rehabilitation plan.

(B) Other Disposal Areas. The term "waste" as used in this subsection (B) means all waste other than mine waste. In accordance with approved plans, the Lessee shall collect, recycle or dispose of waste in sanitary land fills or other disposal areas, and shall use the best practicable portable or permanent waste disposal systems as approved by the Mining Supervisor. The Lessee shall remove or otherwise dispose of all waste in a manner acceptable to the Mining Supervisor, and in accordance with all applicable standards and guidelines of the state, the United States Public Health Service and the Environmental Protection Agency.

(C) Disposal of Solid and Liquid Wastes. The Lessee shall design and construct disposal systems for solid and liquid wastes so as to avoid landslides, control erosion by wind and water, and establish conditions conducive to vegetative growth in the disposal area. The Lessee shall select

and prepare disposal sites for wastes so as to avoid downward percolation of leached products and other pollutants in aquifers.

(D) Impoundment of Water. No disposal of mine waste, other waste, or the residue from any activity under this lease shall be disposed of in a manner which could cause an impoundment of water unless plans for spillways and means of diversion and the prevention of both surface and underground water contamination have been prepared by the Lessee and approved by the Mining Supervisor, and the Lessee has complied with those plans.

(E) Slurry Waste Disposal. Whenever slurry waste disposal is used the Lessee shall provide impoundments sufficient to contain landslides, mud flows, or waste pile blowouts.

Section 15. SOCIOECONOMICS

(A) Assessment Report. The Lessee shall prepare a Socioeconomic Assessment Report together with the detailed development plan required under Section 10(a) of the Lease. This report will consist of a description of existing socioeconomic conditions; an analysis of impacts that will accompany construction, mining, and processing on the leased lands; and proposed mitigation measures which may be implemented to assist in dealing with these socioeconomic impacts. In preparing the Socioeconomic Assessment Report. The Lessee may supplement site specific data with data compiled by others. The Lessee will provide to the Mining Supervisor all other available plans and projections that could be beneficial to planners in health, education, transportation, housing, recreation, and public and social services.

(B) Monitoring. The Lessee shall develop a socioeconomic monitoring program together with the detailed development plan. The purpose of the monitoring program is to provide a record of changes in the socioeconomic environment from conditions existing prior to development, and to determine the effects of the implemented mitigation measures. The Lessee shall maintain records of all information obtained under the monitoring program and shall submit to the Mining Supervisor a report of the socioeconomic monitoring program as part of the annual progress report required under Section 10(c) of the Lease and otherwise make such data available to concerned government agencies.

(C) Community Affairs Officer. The Lessee shall designate a Community Affairs Officer to work directly with the appropriate Federal, State, and local authorities. This official will maintain communication with planning personnel in order to inform them of the Lessees' plans and activities, and assist in providing technical services for planning, as required. The Lessees' efforts shall be directed toward cooperation with and assistance to local and regional entities in alleviating socioeconomic impacts and assuring a well ordered community development process.

APPENDIX B

SOCIAL

APPENDIX TABLES

TABLE B-1
TOTAL COMMUNITY POPULATION IMPACTS - BY YEARS, 1985-1993
LOW PRODUCTION LEVEL - ONE TRACT

	Silt/ New Castle	Rifle	Parachute/ Battlement Mesa	Glenwood/ Carbondale	Total Garfield County	Rangely	Meeker	Total Rio Blanco County	Grand Junction
1985 Construction	17	318	10	0	345	46	216	262	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	363	0	80	443	40	171	211	
Total	17	681	10	80	788	86	387	473	
1986 Construction	39	721	24	0	784	91	431	522	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	667	0	146	813	81	346	427	
Total	39	1,388	24	146	1,597	172	777	949	
1987 Construction	59	1,087	35	0	1,181	136	642	778	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	1,023	0	225	1,248	124	526	650	
Total	59	2,110	35	225	2,429	260	1,168	1,428	
1988 BASELINE	5,100	11,300	8,100	15,800	40,300	4,200	5,800	10,000	78,500
1988 Construction	78	1,429	46	0	1,553	207	976	1,183	
Operations	11	201	7	0	219	31	145	176	
Non-Basic	0	1,524	0	335	1,859	148	630	778	100
Total	89	3,154	53	335	3,631	386	1,751	2,137	
1989 Construction	61	1,129	37	0	1,227	142	667	809	
Operations	22	397	13	0	432	49	232	281	
Non-Basic	0	1,406	0	309	1,715	169	720	889	
Total	83	2,932	50	309	3,374	360	1,619	1,979	
1990 Construction	45	834	28	0	907	104	493	597	
Operation	32	584	19	0	635	72	342	414	
Non-Basic	0	1,284	0	282	1,566	154	657	811	
Total	77	2,702	47	282	3,108	330	1,492	1,822	
1991 Construction	30	547	18	0	595	69	323	392	
Operations	41	762	25	0	828	94	445	539	
Non-Basic	0	1,160	0	255	1,415	138	589	727	
Total	71	2,469	43	255	2,838	301	1,357	1,658	
1992 Construction	15	269	8	0	292	34	159	193	
Operations	50	926	31	0	1,007	115	541	656	
Non-Basic	0	1,034	0	227	1,261	123	522	645	
Total	65	2,229	39	227	2,560	272	1,222	1,494	
1993 BASELINE	4,900	10,000	7,800	15,100	37,800	4,000	5,500	9,500	80,200
1993 Construction	0	0	0	0	0	0	0	0	
Operations	59	1,078	35	0	1,172	134	633	767	
Non-Basic	0	902	0	198	1,100	107	455	562	400
Total	59	1,980	35	198	2,272	241	1,088	1,329	

TABLE B-2
TOTAL COMMUNITY POPULATION IMPACTS - BY YEARS, 1985-1993
HIGH PRODUCTION LEVEL - ONE TRACT

	Silt/ New Castle	Rifle	Parachute/ Battlement Mesa	Glenwood/ Carbondale	Total Garfield County	Rangely	Meeker	Total Rio Blanco County	Grand Junction
1985 Construction	25	468	15	0	508	59	276	335	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	447	0	98	545	57	244	301	
Total	25	915	15	98	1,053	116	520	636	
1986 Construction	51	933	30	0	1,014	117	554	671	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	906	0	199	1,105	114	487	601	
Total	51	1,839	30	199	2,119	231	1,041	1,272	
1987 Construction	76	1,400	46	0	1,522	176	829	1,005	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	1,376	0	302	1,678	172	732	904	
Total	76	2,776	46	302	3,200	348	1,561	1,909	
1988 BASELINE	5,100	11,300	10,300	15,800	42,500	5,000	6,200	11,200	81,600
1988 Construction	100	1,847	60	0	2,007	232	1,094	1,326	
Operations	14	248	8	0	270	31	148	179	
Non-Basic	0	2,028	0	445	2,473	249	1,063	1,312	100
Total	114	4,123	68	445	4,750	512	2,305	2,817	100
1989 Construction	79	1,459	48	0	1,586	183	863	1,046	
Operations	27	491	16	0	534	62	291	353	
Non-Basic	0	1,848	0	406	2,254	225	957	1,182	
Total	106	3,798	64	406	4,374	470	2,111	2,581	
1990 Construction	59	1,078	35	0	1,172	135	639	774	
Operation	39	726	24	0	789	90	426	516	
Non-Basic	0	1,668	0	366	2,034	200	853	1,053	
Total	98	3,472	59	366	3,995	425	1,918	2,343	
1991 Construction	39	708	23	0	770	89	418	507	
Operations	51	946	31	0	1,028	118	555	673	
Non-Basic	0	1,485	0	326	1,811	175	748	923	
Total	90	3,139	54	326	3,609	382	1,721	2,103	
1992 Construction	19	349	11	0	379	44	205	249	
Operations	63	1,155	37	0	1,255	143	676	819	
Non-Basic	0	1,298	0	285	1,583	152	647	799	
Total	82	2,802	48	285	3,217	339	1,528	1,867	
1993 BASELINE	5,000	12,400	12,500	15,100	45,000	4,900	6,200	11,100	86,700
1993 Construction	0	0	0	0	0	0	0	0	
Operations	73	1,344	44	0	1,461	167	785	952	
Non-Basic	0	1,115	0	245	1,360	128	545	673	500
Total	73	2,459	44	245	2,821	295	1,330	1,625	500

TABLE B-3
TOTAL COMUNITY POPULATION IMPACTS - BY YEARS, 1985-1993
LOW PRODUCTION LEVEL - BOTH TRACTS

	Silt/ New Castle	Rifle	Parachute/ Battlement Mesa	Glenwood/ Carbondale	Total Garfield County	Rangely	Meeker	Total Rio Blanco County	Grand Junction
1985 Construction	34	636	40	0	690	92	432	524	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	726	0	160	886	80	342	422	
Total	34	1,362	40	160	1,576	172	774	946	
1986 Construction	78	1,442	48	0	1,568	182	862	1,044	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	1,334	0	292	1,626	162	692	854	
Total	78	2,776	48	292	3,194	344	1,554	1,898	
1987 Construction	118	2,174	70	0	2,362	272	1,284	1,556	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	2,046	0	450	2,496	248	1,052	1,300	
Total	118	4,220	70	450	4,858	520	2,336	2,856	
1988 BASELINE	5,100	11,300	8,100	15,800	40,300	4,200	5,800	10,000	78,500
1988 Construction	156	2,858	92	0	3,106	414	1,952	2,366	
Operations	22	402	14	0	438	62	290	352	
Non-Basic	0	3,048	0	670	3,718	296	1,260	1,556	200
Total	178	6,308	106	670	7,262	772	3,502	4,274	200
1989 Construction	122	2,258	74	0	2,454	284	1,334	1,618	
Operations	44	794	26	0	864	98	464	562	
Non-Basic	0	2,812	0	618	3,430	338	1,440	1,778	
Total	166	5,864	100	618	6,748	720	3,238	3,958	
1990 Construction	90	1,668	56	0	1,814	208	986	1,194	
Operation	64	1,168	38	0	1,270	144	684	828	
Non-Basic	0	2,568	0	564	3,132	308	1,314	1,622	
Total	154	5,404	94	564	6,216	660	2,984	3,644	
1991 Construction	60	1,094	36	0	1,190	138	646	784	
Operations	82	1,524	50	0	1,656	188	890	1,078	
Non-Basic	0	2,320	0	510	2,830	276	1,178	1,454	
Total	142	4,938	86	510	5,676	602	2,714	3,316	
1992 Construction	30	538	16	0	584	68	318	386	
Operations	100	1,852	62	0	2,014	230	1,082	1,312	
Non-Basic	0	2,068	0	454	2,522	246	1,044	1,290	
Total	130	4,458	78	454	5,120	544	2,444	2,988	
1993 BASELINE	4,900	10,000	7,800	15,100	37,800	4,000	5,500	9,500	80,200
1993 Construction	0	0	0	0	0	0	0	0	
Operations	118	2,156	70	0	2,344	268	1,266	1,534	
Non-Basic	0	1,804	0	396	2,200	214	910	1,124	800
Total	118	3,960	70	396	4,544	482	2,176	2,658	800

TABLE B-4
TOTAL COMMUNITY POPULATION IMPACTS - BY YEARS, 1985-1993
HIGH PRODUCTION LEVEL - BOTH TRACTS

	Silt/ New Castle	Rifle	Parachute/ Battlement Mesa	Glenwood/ Carbondale	Total Garfield County	Rangely	Meeker	Total Rio Blanco County	Grand Junction
1985 Construction	50	936	30	0	1,016	118	552	670	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	894	0	96	1,090	114	488	602	
Total	50	1,830	30	96	2,106	232	1,040	1,272	
1986 Construction	102	1,866	60	0	2,028	234	1,108	1,342	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	1,812	0	398	2,210	228	974	1,202	
Total	102	3,678	60	398	4,238	462	2,082	2,544	
1987 Construction	152	2,800	92	0	3,044	352	1,658	2,010	
Operations	0	0	0	0	0	0	0	0	
Non-Basic	0	2,752	0	604	3,356	344	1,464	1,808	
Total	152	5,552	92	604	6,400	696	3,122	3,818	
1988 BASELINE	5,100	11,300	10,300	15,800	42,500	5,000	6,200	11,200	81,600
1988 Construction	200	3,694	120	0	4,014	464	2,188	2,652	
Operations	28	496	16	0	540	62	296	358	
Non-Basic	0	4,056	0	890	4,946	498	2,126	2,624	200
Total	228	8,246	136	890	9,500	1,024	4,610	5,634	200
1989 Construction	158	2,918	96	0	3,172	366	1,726	2,092	
Operations	54	982	32	0	1,068	124	582	706	
Non-Basic	0	3,696	0	812	4,508	450	1,914	2,364	
Total	212	7,596	128	812	8,748	940	4,222	5,162	
1990 Construction	118	2,156	70	0	2,344	270	1,278	1,548	
Operation	78	1,452	48	0	1,578	180	852	1,032	
Non-Basic	0	3,336	0	732	4,068	400	1,706	2,106	
Total	196	6,944	118	732	7,990	850	3,836	4,686	
1991 Construction	78	1,416	46	0	1,540	178	836	1,014	
Operations	102	1,892	62	0	2,056	236	1,110	1,346	
Non-Basic	0	2,970	0	652	3,622	350	1,496	1,846	
Total	180	6,278	108	652	7,218	764	3,442	4,206	
1992 Construction	38	698	22	0	758	88	410	498	
Operations	126	2,310	74	0	2,510	286	1,352	1,638	
Non-Basic	0	2,596	0	570	3,166	304	1,294	1,598	
Total	164	5,604	96	570	6,434	678	3,056	3,734	
1993 BASELINE	5,000	12,400	12,500	15,100	45,000	4,900	6,200	11,100	86,700
1993 Construction	0	0	0	0	0	0	0	0	
Operations	146	2,688	88	0	2,922	334	1,570	1,904	
Non-Basic	0	2,230	0	490	2,720	256	1,090	1,346	1,000
Total	146	4,918	88	490	5,642	590	2,660	3,250	1,000

TABLE B-5
COMPARATIVE SOCIAL IMPACTS OF VARIOUS ALTERNATIVES ON COMMUNITIES,
PEAK AND FULL OPERATION STAGES (1988 AND 1993)

	No Action High	No Action Low	Low Level Prod. C-18 Only	Low Level Prod. C-11 Only	High Level Prod. C-18 Only	High Level Prod. C-11 Only	Low Level Prod. Both Tracts	High Level Prod. Both Tracts
Silt/New Castle								
1988								
Baseline	5,100	5,100*	5,100	5,100	5,100	5,100	5,100	5,100
Peak Impact			89	89+**	114	114+	178	228
% Impact			1.7	1.7+	2.2	2.2+	3.5	4.5
1993								
Baseline	5,000	4,900*	4,900	4,900	5,000	5,000	4,900	5,000
Full Operation			59	59+	73	73+	118	146
% Impact			1.2	1.2+	1.5	1.5+	2.4	2.9
Rifle								
1988								
Baseline	11,300	11,300*	11,300	11,300	11,300	11,300	11,300	11,300
Peak Impact			3,154	3,154+	4,123	4,123+	6,308	8,246
% Impact			27.9	27.9+	36.5	36.5+	55.8	73.0
1993								
Baseline	12,400	10,000*	10,000	10,000	12,400	12,400	10,000	12,400
Full Operation			1,980	1,980+	2,459	2,459+	3,960	4,918
% Impact			19.8	19.8+	19.8	19.8+	39.6	39.7
Parachute/Battlement								
1988								
Baseline	10,300	8,100*	8,100	8,100	10,300	10,300	8,100	10,300
Peak Impact			53	53+	68	68+	106	136
% Impact			.7	.7+	.7	.7+	1.3	1.3
1993								
Baseline	12,500	7,800*	7,800	7,800	12,500	12,500	7,800	12,500
Full Operation			35	35+	44	44+	70	88
% Impact			.4	.4+	.4	.4+	.9	.7
Glenwood/Carbondale								
1988								
Baseline	15,800	15,800*	15,800	15,800	15,800	15,800	15,800	15,800
Peak Impact			335	335+	445	445+	670	890
% Impact			2.1	2.1+	2.8	2.8+	4.2	5.6
1993								
Baseline	15,100	15,100*	15,100	15,100	15,100	15,100	15,100	15,100
Full Operation			198	198+	245	245+	396	490
% Impact			1.3	1.3+	1.6	1.6+	2.6	3.2
Rangely								
1988								
Baseline	5,000	4,200	4,200	4,200	5,000	5,000	4,200	5,000
Peak Impact			386	386+	512	512+	772	1,024
% Impact			9.2	9.2+	10.2	10.2+	18.4	20.5
1993								
Baseline	4,900	4,000	4,000	4,000	4,900	4,900	4,000	4,900
Full Operation			241	241+	295	295+	482	590
% Impact			6.0	6.0+	6.0	6.0+	12.0	12.0
Meeker								
1988								
Baseline	6,200	5,800	5,800	5,800	6,200	6,200	5,800	6,200
Peak Impact			1,751	1,751+	2,305	2,305+	3,502	4,610
% Impact			30.2	30.2+	37.2	37.2+	60.4	74.4
1993								
Baseline	6,200	5,500	5,500	5,500	6,200	6,200	5,500	6,200
Full Operation			1,088	1,088+	1,330	1,330+	2,176	2,660
% Impact			19.8	19.8+	21.5	21.5+	39.6	42.9
Grand Junction								
1988								
Baseline	81,600	78,500*	78,500	78,500	81,600	81,600	78,500	81,600
Peak Impact			100	100+	100	100+	200	200
% Impact			.1	.1+	.1	.1+	.3	.2
1993								
Baseline	86,700	80,200*	80,200	80,200	86,700	86,700	80,200	86,700
Full Operation			400	400+	500	500+	800	1,000
% Impact			.5	.5+	.6	.6+	1.0	1.2

* Population baseline projections were computed prior to close down of the Colony Oil Shale project in Parachute Canyon and cancellation of the La Sal Pipeline project. Therefore these estimates are much too high. Our deadlines did not allow re-calculations.

** The Multi-Mineral Corp. project on Tract C-18 is expected to proceed on schedule unless tract is leased, in which case this project would be absorbed into the C-18 development. Thus, if only C-11 is leased, the Multi-Mineral project would represent an additional impact in population which is not estimated here but which could amount to several hundred persons in the area.

GLOSSARY

GLOSSARY

ACCIPETERS. The family of long-tailed hawks with short, rounded wings; chiefly woodland birds that do not soar.

ACTIVE NEST. An active raptor nest is one which: (a) is known to have been used by nesting raptors in at least one of the three preceeding years, or (b) is in such condition that prior use by raptors can be verified, and little or no repair will be required for its subsequent use for nesting.

AIRSHEDS. These are the areas in which weak dispersion conditions result from the effects of obstructions on the normal wind flow pattern. These obstructions are elevated topographic features, such as mountain ranges or canyon walls.

ALLOTMENT. An area of land where one or more operators graze their livestock. It generally consists of public lands but may include parcels of private or state owned lands. The number of livestock and period of use are stipulated for each allotment. An allotment may consist of several pastures or be only one pasture.

ALLOTMENT MANAGEMENT PLAN (AMP). A concisely written program of livestock grazing management, including supportive measures, if required, designed to attain specific multiple use management goals in a grazing allotment.

ALLUVIAL SOIL. A soil developing from recently deposited alluvium and exhibiting essentially no horizon development or modification of the recently deposited materials.

ALLUVIUM. Clay silt, sand, gravel, or other rock materials transported by flowing water. Deposited in comparatively recent geologic time as sorted or semisorted sediment in riverbeds, estuaries, and floodplains, on lakes, shores, and in fans at the base of mountain slopes and estuaries.

AMBIENT AIR QULAITY. The state of the atmosphere at ground-level as defined by the range of measured and/or predicted ambient concentrations of all significant pollutants for all averaging periods of interest.

ANIMAL UNIT MONTH (AUM). The amount of forage necessary for the subsistence of one cow or its equivalent for a period of one month.

ANTHROPOGENIC. Relating to man's activities. Anthropogenic pollutant sources include space heating, vehicular traffic, industrial activity and construction.

ATMOSPHERIC DISPERSION MODEL. A mathematical simulation of the atmospheric transport and dispersion of pollutants used to predict pollutant concentrations.

BACKGROUND CONCENTRATION. A pollutant level which could be expected in an area in the absence of any anthopogenic pollutant sources.

BAGHOUSE. A stationary source pollution control system which filters particulates at over 99 percent efficiency.

BIOLOGICAL ASSESSMENT. A procedural step in the Interagency consultation process under Section 7 of the Endangered Species Act where the BLM submitted a written summary of potential project impacts to threatened or endangered species to the USFWS for their evaluation.

BRECCIA. A fragmental rock, the components of which are angular. Any rock formation essentially composed of ucemented, or loosely consolidated, small, angular shaped fragments.

CALCINE. To expel volatile matter by heating, with or without oxidation; roasting of ore.

CANOPY COVER. See plant cover (aerial).

CARRYING CAPACITY. The maximum number of animals possible without inducing damage to vegetation or related resources. Carrying capacity may vary from year to year on the same area due to fluctuating forage production.

CHIMNEY DRAIN. Verticle drainage structure constructed internally within spent shale and processing waste disposal piles.

CLIMATE. The statistical collective of an area's weather conditions during a relatively long interval of time (usually several decades).

COLLUVIUM. Loose and incoherent deposits, usually at the foot of a slope or cliff and brought there cheifly by gravity. Talus and cliff debris are included in such deposits.

COMMERICAL WOODLAND. Is a pinyon-juniper stand that must: (1) have volumes of timber, preferably pinyon, adequate for economic harvest, (2) be located on slopes less than 25 to 30 percent, and (3) be in close proximity to existing roads.

COMPOSITION. The proportions of various plant species in relation to the total in a given area.

CONTRAST. The relative difference in luminance between an object and its background. Inherent contrast is contrast as perceived at the position of the observed object. Apparent contrast is contrast as perceived at the observer's position.

CRITICAL WINTER RANGE. That area where all individuals of the species of interest are located at the point in time when distribution is most restricted over an average five winters out of ten.

DEFERRED ROTATION SYSTEM. Discontinuance of grazing on various parts of a range in succeeding years, allowing each part to rest successively during the growing season to permit seed production, establishment of seedlings, or restoration of plant vigor.

DIP. The angle at which a bed, stratum, or vein is inclined from the horizontal plane. It may vary from a perpendicular to the earths surface to an angle perhaps only a few degrees below the horizon.

DISTILLATE. The liquid obtained by condensing a vapor.

DISPERSION POTENTIAL. The ability of the atmosphere to dilute or disperse air pollutants, as determined by normal ventilation values. A high dispersion potential results from high ventilation values, which can be caused by high transport wind speeds, high mixing heights, or high values of both.

DUIRNAL. Pertains to meterological actions that are completed over a day and night cycle.

EMISSION FACTOR. An empirically derived mathematical relationship between pollutant emission rate and some characteristic of the source such as volume, area, mass, or process output.

ENDANGERED SPECIES. Any species which is in danger of extinction throughout all or a significant portion of its range.

ENDEMIC SPECIES. A species whose natural occurrence is confined to a certain region and whose distribution is relatively limited.

EVAPORATION. The physical process by which a liquid or solid is transformed to the gaseous state.

EVAPOTRANSPIRATION. The combined loss of water from a given area during a specific period of time, by evaporation from the soil or water surface and by transpiration from plants.

FUGITIVE DUST. A type of particulate emission made airborne by forces of wind, man's activity, or both, such as unpaved roads, construction sites, tilled land, or windstorms.

GAME FISH. Any fish species for which seasons and bag limits are prescribed; fish worthy of pursuit for sport or food.

GRABEN. A depressed segment of the earths crust bounded on at least two sides by faults and generally of considerable length as compared with its width.

GRAZING CAPACITY. As used in this document, the maximum amount of livestock use permitted on an allotment per year.

GROUND COVER. The area of ground surface occupied by the stem(s) of a range plant, as contrasted with the full spread of its herbage or foliage, generally measured at one inch above soil level.

GROWING SEASON. Generally, the period of the year during which the temperature of cultivated vegetation remains sufficiently high to allow plant growth.

GLOSSARY

HABITAT. A specific set of physical conditions that surround a single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover, and living space.

HALITE. Impure common salt, NaCl (sodium-choride); cubic crystals. Occurs widely disseminated or in extensive beds and irregular masses, and interstratified with rocks of other types as a true sedimentary rock.

HERBACEOUS. Green plants with leaflike appearance or texture, not including shrubs, trees, mosses, or lichens.

HERBAGE. Usually used in the same sense as forage, except that it may include material not acceptable to grazing or browsing animals.

HABITAT EFFECTIVENESS. The actual capability of a habitat site to support a wildlife population. It is determined by calculating the total productive potential minus any natural or man-caused impacts or factors which make an area to be less than fully effective for wildlife use.

HYDROCARBON. A chemical compound comprised of only carbon and hydrogen.

INDIRECT IMPACTS. Impacts caused by something which, itself, is a result of something else. In economics, indirect impacts are caused by growth in trade and service activities which, themselves, result from a primary source of growth such as mining.

INTERFACE. Contact boundary either between spent shale wastes and native rock or soil. Could be the boundary between differing layers of spent shale.

IRRIGATED PASTURE LAND AND HAYLAND OF STATEWIDE IMPORTANCE. These are lands which for one or more reasons, do not meet the requirements for prime farmland. However, lands in this category are important to the agricultural economy in Colorado.

JOINT FREQUENCY DISTRIBUTION. Set of meterological data describing the concurrent frequencies of occurrence of defined wind directions, wind speed classes, and atmospheric stabilities.

MASS WASTING. The slow movement of rock debris downslope in large masses of material moving either quickly or slowly.

METER. The basic metric unit of lengths; one meter is equivalent to 3.28 feet.

MIXING HEIGHT. The height above the ground to which turbulence causes the air to be well mixed.

MODELING. A mathematical or physical representation of an observable situation. In air pollution control, models afford the ability to predict pollutant distributionor dispersion from identified sources for specified weather conditions.

MOLYBDENOSIS. Molybdenum poisoning is the consumption of forage on soils of a molybdenum-copper inbalance of sufficient quantity to provide toxic results to ruminents. Prominent symptoms in cattle include emaciation, scours, anemia, stiffness, reproductive difficulty and occasionally death.

NEPHELOMETER. An instrument whch measures the scattering coefficient of an air sample which can be interpreted as visual range.

OPERATOR. See permittee.

OVERSTORY. That portion of a plant community that is dominant as to height, the tallest plants on a given site.

PASQUILL STABILITY CLASS E. The stability category which corresponds to nightime meterological conditions with less than 3/8 cloud cover and surface winds between 2 and 5 meters per second.

PASSERINE. Is the order and classification of perching birds.

PASTURE. Is a subdivision of a grazing allotment on public lands. The number of pastures is variable between allotments.

PERMITTEE. Holder of a license or permit for grazing on an allotment.

pH. A measure of the acidity or alkalinity of a solution. Water is considered to be neutral at a pH of 7, acid if pH is less than 7, and basic if greater than 7.

PHOTOCHEMICAL REACTION. Chemical reaction in which the activation energy (driving force) is supplied by solar radiation.

PLANT COVER. The percent of an area covered by any part of living plant material (aerial plant cover), or that percent area occupied by the portion of living plants at the point of emergence from the ground (basal plant cover).

POINT SOURCE. A pollutant source whose origin of emissions can be approximated by a single point.

POLLUTANT. Any gaseous, chemical, or organic waste that contaminates air, soil, or water.

POLLUTION. The contamination of soil, water, or the atmosphere by the discharge of noxious substances.

PREVAILING WIND. The most frequent compass direction from which the wind blows.

PRIME FARMLAND. In general, prime farmlands in Colorado have adequate and dependable water supply from irrigation (a dependable water supply is one in which enough water is available for irrigation in 8 out of 10 years, for crops commonly grown); a favorable temperature and growing season; acceptable acidity or alkalinity; acceptable salt and sodium content; and few or no rocks. They are permeable to water and air. Prime Farmlands are not excessively erodible or saturated with water for long periods of time and they either do not flood frequently or are protected from flooding.

RADIATIONAL COOLING. The cooling of the earth's surface and adjacent air, accomplished (mainly at night) whenever the earth's surface suffers a net loss of heat.

RADIOMETER. An instrument which measures the apparent deradiance of a target and its apparent background radiance which can be interpreted as visual drange.

RANGE SITE. A type of rangeland with inherently different soil characteristics that produce a significantly different kind or amount of potential vegetation.

RAPTOR. Birds of prey with sharp talons and strongly curved beaks; e.g., hawks, owls, eagles, falcons.

RETORT. A vessel used for solid to liquid distillation of oil shale by applying indirect or direct heat. Can occur in above ground facilities or below ground in place.

REGIONAL VISIBILITY. Visibility predicted to occur in the region around a source or group of sources resulting from particulate, sulfate, and hitrate concentrations in the vicinity of these sources.

RILL. A small intermittent water course with steep sides, less than 6 inches deep.

RIPARIAN. Situated on or pertaining to the bank of a river, stream, or other body of water. Normally used to refer to the plants of all types that grow rooted in the watertable of streams, ponds, and springs.

SECONDARY IMPACTS. See INDIRECT IMPACTS.

SENSITIVE SPECIES. A species included on the sensitive species list developed by the Colorado State Office pursuant to section CL of Instruction Memorandum No. 80-722 and approved by the State Director. These lists will generally include any species in the State which meet any of the following criteria:

a. Candidate species are any species not yet officially listed by which are undergoing a status review or are proposed for listing according to *Federal Register* notices published by the Secretary of the Interior or the Secretary of Commerce.

b. Rare or infrequent species whose populations are consistently small and widely dispersed, or whose ranges are restricted to a few localities, such that any appreciable reduction in numbers, habitat, or habitat condition might lead toward extinction.

c. Other species whose numbers are declining so rapidly that official listing may become necessary as a conservation measure. Declines may be the result of one or more of several factors including: overuse

for commercial, scientific, or educational purposes; disease, predation, or grazing; the inadequacy of existing regulatory mechanisms; and/or other natural or human factors adversely affecting the species continued existence.

SHEET EROSION. The removal of a fairly uniform layer of soil from the land surface by runoff water.

SLOPE FAILURE. Downward and outward movement of waste material (spent shale) in an unconsolidated mass; (slumped); material that has slid down from a higher position on a slope.

SOIL HORIZON. A layer of soil, approximately parallel to the soil surface, with comparatively uniform characteristics, but differs from adjacent layers.

SPECIES. An organism which is, and remains, distinct because it does not normally interbreed with other organisms.

STRATIGRAPHY. Descriptive geology of an area or district which pertains to the descrimination, character, thickness, sequence, age, and correlation of the rocks.

STRATOPHERIC. Pertaining to the stratosphere, the atmospheric layer above the tropopause; a very stable layer characterized by low moisture content and absence of cloud.

SYNOPTIC. Weather patterns associated with high and low pressure systems in the lower trophosphere.

THREATENED SPECIES. Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

THORACIC PARTICULATES. Also known as inhalable particulates. Particles less than 15 microns in diameter which are not filtered in the nostrils and can be lodged in the windpipe and lungs causing health damage.

TOPOGRAPHY. The exact physical features and configuration of a place or region; the detailed and accurate description of a plan or region.

TOPSOIL. Presumed fertile soil or soil material, usually rich in organic matter, used to top-dress road banks, parks, and other similar areas.

TOTAL SUSPENDED PARTICULATES (TSP). The portion of the total particulate matter in the atmosphere consisting of particles so small that the particles settle out very slowly.

TRANSPORT WIND. The average horizontal wind speed component perpendicular to a vertical cross section of the atmosphere. In this report, the vertical limits are defined by the ground and the mixing height.

UNDERSTORY. That portion of a plant community that grows underneath taller plants growing on the same site.

UNIQUE FARMLAND. Unique Farmland is land other than Prime Farmland that is used for the production of specific high value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yield of a specific crop, when treated and managed according to acceptable farming methods. In Colorado only fruit orchards and vegetable producing areas of high production are considered unique.

VEGETATION TYPE. A plant community with immediately distinguishable characteristics, based upon and named after the apparent dominant plant species.

VISIBILITY. A measurement of the maximum distance to which large objects may be viewed. Fixed reference objects such as mountains, hills, towers, or buildings are normally used to estimate visibility.

VISUAL RANGE. A standardized form of visibility that approximates actual observed visibility. It is the maximum distance at which an average human eye with a threshold perceivable brightness contrast of .02 at a wavelength of 5,500 Angstroms can detect an ideal back object against the horizon sky in daylight.

WET ADIABATIC LAPSE RATE. The standard rate of decreasing temperature of moist air with increasing altitude (at constant energy).

WIND ROSE. A graphical display of wind speed and wind direction frequencies at a meterological station. The bar graphs extend into the direction from which the wind blows. These directions are the sixteen compass point directions (i.e., north, north-northeast, ..., northwest, and north-northwest).

WINTER RANGE. That area where all individuals of the species of interest are located in over an average five winters out of ten during the period 15 December to 15 March.

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